This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 3 9015 00211 107 1
University of Michigan - BUHR

MEDICAL AND SURGICAL REPORT

OF THE

PRESBYTERIAN HOSPITAL

IN THE

CITY OF NEW YORK.

VOLUME IX
JULY, 1912

EDITED BY
JOHN S. THACHER, M.D.
GEORGE WOOLSEY, M.D.

Digitized by Google

RECEIVED IN EXCHANGE
FROM
Harvard Med. Library

Digitized by Google

610.5
N56
P93
Han

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

MEDICAL AND SURGICAL REPORT

OF THE

PRESBYTERIAN HOSPITAL

IN THE

CITY OF NEW YORK.

VOLUME IX
JULY, 1912

EDITED BY

JOHN S. THACHER, M.D.
GEORGE WOOLSEY, M.D.

CORLIES MACY & COMPANY, Inc.
PRINTERS
NEW YORK, N. Y.

Digitized by Google

Digitized by Google

OFFICERS

PRESIDENT

FREDERICK STURGES

VICE-PRESIDENT

ROBERT W. DeFOREST

TREASURER

WILLIAM V. S. THORNE

41 East 70th Street

RECORDING SECRETARY

MATTHEW C. FLEMING

71 Broadway

CORRESPONDING SECRETARY

WILLIAM M. KINGSLEY

47 Wall Street

399707

Digitized by Google

MANAGERS

CLASS OF 1913

FREDERICK STURGES.
HUGH D. AUCHINCLOSS.
J. CLEVELAND CADY.
ARTHUR P. STURGES.
WILLIAM SLOANE.
HENRY W. DEFOREST,
E. PARMALEE PRENTICE.

CLASS OF 1914

JOHN T. TERRY.
WILLIAM F. HAVEMEYER.
ETHAN ALLEN.
WILLIAM V. S. THORNE.
JOHN S. BILLINGS, M.D.
MATTHEW C. FLEMING.
EUGENE DELANO.
WM. ALLEN BUTLER, JR.

CLASS OF 1915

FREDERIC BAKER.
ROBERT W. DEFOREST.
CHARLES W. MCALPIN.
JOHN J. SINCLAIR.
DAVID M. LOOK.
EDWARD S. HARKNESS.
JAMES R. SHEFFIELD.
GEORGE GIBBS.

CLASS OF 1916

ELBERT A. BRINCKERHOFF.
HENRY S. VAN DUZER.
SIMEON B. CHAPIN.
WILLIAM R. WILLCOX.
WILLIAM M. KINGSLEY.
MOREAU DELANO.
WILLIAM SLOANE COFFIN.

Ex-officio.

HOWARD DUFFIELD, D.D.
Minister of the First Presbyterian Church.

CHARLES H. PARKHURST, D.D.
Minister of the Madison Square Presbyterian Church.

EDWARD B. COE, D.D.
Senior Minister of the Collegiate Reformed Church.

DAVID G. WYLIE, D.D.
Minister of the Scotch Presbyterian Church, successor to the First Reformed Presbyterian Church.

Board meets second Tuesday of February, April, June, August, October and December.

Digitized by Google

STANDING COMMITTEES

EXECUTIVE

HENRY S. VAN DUZER,
J. CLEVELAND CADY,
WM. ALLEN BUTLER, JR.,
E. PARMALEE PRENTICE,
WILLIAM SLOANE,
WILLIAM F. HAVEMEYER,
EDWARD S. HARKNESS,
EUGENE DELANO,

And the members of the Inspecting, Dispensary, School of Nursing and House Committees on duty.

Regular meeting at the Hospital on second and fourth Tuesdays of each month.

DISPENSARY

HUGH D. AUCHINCLOSS,
HENRY S. VAN DUZER,
EUGENE DELANO,
WILLIAM M. KINGSLEY,
WILLIAM V. S. THORNE,
GEORGE GIBBS.

FINANCE

WILLIAM M. KINGSLEY,
MOREAU DELANO,
HENRY W. DEFOREST,

And Treasurer *Ex-officio*.

NOMINATING

HENRY S. VAN DUZER,
ELBERT A. BRINCKERHOFF,
HENRY W. DEFOREST.
HUGH D. AUCHINCLOSS,
WILLIAM SLOANE.

And Corresponding Secretary *Ex-officio*.

HOUSE

HENRY S. VAN DUZER,
HUGH D. AUCHINCLOSS.
MOREAU DELANO,
JAMES R. SHEFFIELD.

SCHOOL OF NURSING

FREDERICK STURGES,
WILLIAM F. HAVEMEYER,
HENRY S. VAN DUZER,
JOHN S. THACHER, M.D.,
ELLSWORTH ELIOT, JR., M.D.,
DAVID BOVAIRD, JR., M.D.,
EUGENE DELANO.

Digitized by Google

STANDING COMMITTEES (Continued.)

AUDITING

WILLIAM F. HAVEMEYER, ETHAN ALLEN.

COMMITTEE ON RELATIONS BETWEEN THE HOSPITAL A COLUMBIA UNIVERSITY

ROBERT W. DEFOREST, EDWARD S. HARKNESS,
WILLIAM V. S. THORNE.

BUILDING COMMITTEE

ROBERT W. DEFOREST. HENRY W. DEFOREST,
WILLIAM SLOANE, WILLIAM V. S. THORNE.
JOHN S. BILLINGS, M.D., EDWARD S. HARKNESS.
The President is *Ex-officio* a member of all Committees.

INSPECTING COMMITTEE

1912.

May—
Messrs. SINCLAIR and SLOANE.
June—
Messrs. ALLEN and COE.
July—
Messrs. CADY and SHEFFIELD.
August—
Messrs. FLEMING and LOOK.
September—
Messrs. KINGSLEY and AUCHINCLOSS.
October—
Messrs. FREDERICK STURGES and GIBBS.
November—
Messrs. HAVEMEYER and CHAPIN.
December—
Messrs. THORNE and BUTLER

1913.

January—
Messrs. VAN DUZER and COFF
February—
Messrs. EUGENE DELANO a PRENTICE.
March—
Messrs. BRINCKERHOFF and W. DEFOREST.
April—
Messrs. WYLIE and MORE DELANO.

The By-Laws call for a weekly inspection of all Departments of the Hospit

Digitized by Google

MEDICAL BOARD

OFFICERS

President—WALTER B. JAMES, M.D.
Vice-President—ELLSWORTH ELIOT, Jr., M.D.
Secretary—DAVID BOVAIRD, Jr., M.D.

EXECUTIVE COMMITTEE

WALTER B. JAMES, M.D., *Chairman.*
And the Physicians and Surgeons in attendance at the Hospital

EXAMINING COMMITTEE

ELLSWORTH ELIOT, Jr., M.D.
WARFIELD T. LONGCOPE, M.D.

CONSULTING SURGEONS.

CHARLES McBURNEY, M.D.
CHARLES K. BRIDDON, M.D.

VISITING PHYSICIANS

FRANCIS P. KINNICUTT, M.D.
WILLIAM P. NORTHRUP, M.D.
WALTER B. JAMES, M.D.
JOHN S. THACHER, M.D.
THEODORE C. JANEWAY, M.D.

VISITING SURGEONS

ELLSWORTH ELIOT, Jr., M.D.
JOSEPH A. BLAKE, M.D.

ASSOCIATE VISITING PHYSICIANS

GEORGE A. TUTTLE, M.D.
DAVID BOVAIRD, Jr., M.D.
WARFIELD T. LONGCOPE, M.D.
T. STUART HART, M.D.

ASSOCIATE VISITING SURGEONS

GEORGE WOOLSEY, M.D.
FORBES HAWKES, M.D.
ADRIAN VAN S. LAMBERT, M.D.

VISITING PATHOLOGIST

WILLIAM G. MacCALLUM, M.D.

VISITING PHYSICIAN TO THE ROENTGEN RAY DEPARTMENT

EUGENE WILSON CALDWELL, M.D.

Digitized by Google

ASSISTANT VISITING PHYSICIANS AND SURGEONS, AND ASSOCIATE AND ASSISTANT VISITING PATHOLOGISTS, AND SPECIAL CONSULTANTS

(Not Members of the Medical Board.)

ASSISTANT VISITING PHYSICIANS

HERBERT S. CARTER, M.D.
HERMAN O. MOSENTHAL, M.D.
ARTHUR W. SWANN, M.D.
GEORGE DRAPER, M.D.

ASSISTANT VISITING SURGEONS

CLARENCE A. McWILLIAMS, M.D.
JOHN A. HARTWELL, M.D.
HUGH AUCHINCLOSS, M.D.

SECOND ASSISTANT VISITING SURGEONS

JAMES W. JAMESON, M.D.
JAMES A. CORSCADEN, M.D.

ASSOCIATE VISITING PATHOLOGIST

HUGH A. STEWART, M.D.

ASSOCIATE VISITING SURGICAL PATHOLOGIST

WILLIAM C. CLARKE, M.D.

ASSISTANT VISITING SURGICAL PATHOLOGIST

HUGH AUCHINCLOSS, M.D.

MEDICAL REGISTRAR

GEORGE A. TUTTLE, M.D.

SURGICAL REGISTRAR

HARRY M. KEATOR, M.D.

ANESTHETIST

MARGARET GALT BOISE, R.N.

SPECIAL CONSULTANTS

Gynecology—EDWIN B. CRAGIN, M.D.
Neurology—M. ALLEN STARR, M.D.
Laryngology—W. KELLY SIMPSON, M.D.
Otology—GORHAM BACON, M.D.
Orthopedics—NEWTON M. SHAFFER, M.D.
Ophthalmology—ARNOLD H. KNAPP, M.D.
Dermatology—GEORGE T. JACKSON, M.D.
Anaesthesia—THOMAS L. BENNETT, M.D.
Genito-Urinary—ALFRED T. OSGOOD, M.D.

Digitized by Google

HOUSE OFFICERS

SUPERINTENDENT
C. IRVING FISHER, M.D.

ASSISTANT SUPERINTENDENT
CHARLES H. YOUNG, M.D.

ACTING CHAPLAIN
J. B. TARNEY.

SUPT. SCHOOL OF NURSING
ANNA CAROLINE MAXWELL.

ASST. SUPT. SCHOOL OF NURSING
MRS. JANET B. CHRISTIE.

CHIEF CLERK
FREDERIC B. MORLOK.

APOTHECARY
CHARLES H. LIPSCOMB.

MATRON
JESSIE BOURNE SMILLIE.

ASSISTANT TO THE TREASURER
FREDERIC B. MORLOK

Digitized by Google

PATHOLOGICAL DEPARTMENT

VISITING PATHOLOGIST
WILLIAM G. MacCALLUM, M.D.

ASSOCIATE VISITING PATHOLOGIST
HUGH A. STEWART, M.D.

ASSOCIATE VISITING SURGICAL PATHOLOGIST
WILLIAM C. CLARKE, M.D.

ASSISTANT VISITING SURGICAL PATHOLOGIST
HUGH AUCHINCLOSS, M.D.

RESIDENT PATHOLOGIST
ALBERT R. LAMB, M.D.

EXTERNE PATHOLOGIST
WILLARD B. SOPER, M.D.

LABORATORY ASSISTANT
SELMA GRANAT, PH.G.

ROENTGEN RAY DEPARTMENT

VISITING PHYSICIAN
EUGENE WILSON CALDWELL, M.D.

RADIOGRAPHER
IRA L. SIMMS.

Digitized by Google

OUT-PATIENT DEPARTMENT

OFFICERS

REGISTRAR
CHARLES H. YOUNG, M.D.

MATRON
GRACE I. CAMERON, R.N.

CLERK
ANNA C. HOECKY,

PHARMACIST
CHARLES H. LIPSCOMB.

ATTENDING STAFF

SURGEON IN CHIEF
HUGH AUCHINCLOSS, M.D.

ASSISTANT SURGEONS

FREDERICK C. BANCROFT, M.D.
SIDNEY R. BURNAP, M.D.
JAMES A. CORSCADEN, M.D.
JAMES W. JAMESON, M.D.
HARRY M. KEATOR, M.D.
FREDERICK KNOWLES, M.D.
DUDLEY H. MORRIS, M.D.,
FORDYCE B. ST. JOHN, M.D.
ALEXANDER R. STEVENS, M.D.
ALLEN O. WHIPPLE, M.D.

PHYSICIAN IN CHIEF
HERBERT S. CARTER, M.D.

CHIEFS OF MEDICAL CLINIC

FREDERICK J. BARRETT, M.D.
ARTHUR W. SWANN, M.D.

ASSISTANTS IN GENERAL MEDICINE

PHINEAS H. ADAMS, M.D.,
RUSSELL L. CECIL, M.D.
GEORGE DRAPER, M.D.,
ALPHEUS FREEMAN, M.D.
D. R. PERRY HEATON, M.D.
EDMUND R. P. JANVRIN, M.D.
RICHARD KOVACS, M.D.
NATHANIEL G. McMASTER, M.D.
HARRY G. WATSON, M.D.

ASSISTANTS IN CHILDREN'S DEPARTMENT

GEORGE C. ALBEE, M.D.
M. ALICE ASSERSON, M.D.
W. B. HAMILTON, M.D.
HOWARD H. MASON, M.D.,
PHOEBE M. VAN VOAST, M.D.

ASSISTANTS IN EYE DEPARTMENT

LEWIS W. CRIGLER, M.D.
*FRANK J. PARKER, M.D.

ASSISTANTS IN NOSE, THROAT AND EAR DEPARTMENT

EDMUND W. BILL, M.D.
HUGO BLUM, M.D.
WILLIAM A. DALTON, M.D.
EDWARD FRANKEL, M.D.
ISIDORE FRIESNER, M.D.
J. CLARENCE SHARP, M.D.
EDWARD MILLER, M.D.

ASSISTANTS IN SKIN DEPARTMENT

AUGUSTUS F. BUCHLER, M.D.
A. SCHUYLER CLARK, M.D.
JEROME KINGSBURY, M.D.

ASSISTANTS IN TUBERCULOSIS CLINIC

WILLIAM B. BOYD, M.D.
ATHEL C. BURNHAM, M.D.
OTTO W. GREENBERG, M.D.

PATHOLOGIST
HAROLD E. SANTEE, M.D.

* Died October, 1912.

Digitized by Google

HOUSE STAFF

Medical Division

For the six months ending December 31, 1912.

FIRST DIVISION	SECOND DIVISION
HOUSE PHYSICIAN	**HOUSE PHYSICIAN**
THOMAS A. DEVAN, M.D.	BENJAMIN A. FURMAN, M.D.
FIRST ASSISTANT	**FIRST ASSISTANT**
*FAIRFAX HALL, M.D.	DAVID D. STOWELL, M.D.
SECOND ASSISTANT	**SECOND ASSISTANT**
RODERICK V. GRACE, M.D.	C. J. MACGUIRE, JR., M.D.
THIRD ASSISTANT	**THIRD ASSISTANT**
HUBERT S. HOWE, M.D.	M. DEFOREST SMITH, M.D.

For the six months ending June 30, 1913.

FIRST DIVISION	SECOND DIVISION
HOUSE PHYSICIAN	**HOUSE PHYSICIAN**
_____	DAVID D. STOWELL, M.D.
FIRST ASSISTANT	**FIRST ASSISTANT**
HENRY D. EATON, M.D.	HENRY T. CHICKERING, M.D.
SECOND ASSISTANT	**SECOND ASSISTANT**
STERNE MORSE, M.D.	OTTO CARL PICKHARDT, M.D.
THIRD ASSISTANT	**THIRD ASSISTANT**
HENRY ALSOP RILEY, M.D.	ROBERT W. TOMLINSON, M.D.

Surgical Division

For the six months ending December 31, 1912.

FIRST DIVISION	SECOND DIVISION
HOUSE SURGEON	**HOUSE SURGEON**
JAMES N. WORCESTER, M.D.	MALCOLM K. SMITH, M.D.
FIRST ASSISTANT	**FIRST ASSISTANT**
JAMES L. COBB, M.D.	ALBERT V. FRANKLIN, M.D.
SECOND ASSISTANT	**SECOND ASSISTANT**
HENRY D. EATON, M.D.	HENRY T. CHICKERING, M.D.
THIRD ASSISTANT	**THIRD ASSISTANT**
STERNE MORSE, M.D.	OTTO CARL PICKHARDT, M.D.

For the six months ending June 30, 1913.

FIRST DIVISION	SECOND DIVISION
HOUSE SURGEON	**HOUSE SURGEON**
JAMES L. COBB, M.D.	ALBERT V. FRANKLIN, M.D.
FIRST ASSISTANT	**FIRST ASSISTANT**
RODERICK V. GRACE, M.D.	C. J. MACGUIRE, JR., M.D.
SECOND ASSISTANT	**SECOND ASSISTANT**
HUBERT S. HOWE, M.D.	M. DEFOREST SMITH, M.D.
THIRD ASSISTANT	**THIRD ASSISTANT**
ROBERT H. KENNEDY, M.D.	WILLIAM WEBB WEEKS, M.D.

*Resigned November, 1912

Digitized by Google

CONTENTS.

		PAGE
I.	VISCERAL SARCOMATA. CASES OF SARCOMA OF THE STOMACH, HEART, MEDIASTINUM, ETC. W. Gilman Thompson, M. D.	1
II.	THE ELECTRO-CARDIOGRAM IN CLINICAL MEDICINE. Walter B. James, M.D., and H. B. Williams, M.D.	17
III.	ACUTE PERICARDITIS IN CHILDREN. David Bovaird, Jr., M.D.	61
IV.	MENINGOCOCCUS ENDOCARDITIS WITH SEPTICEMIA. Russell L. Cecil, M.D., and Willard B. Soper, M.D.	83
V.	ERYTHRAEMIA. F. P. Kinnicutt, M.D.	107
VI.	PURPURA. J. S. Thacher, M.D.	115
VII.	TRANSFUSION OF BLOOD IN THREE CASES OF PERNICIOUS ANEMIA. David Bovaird, Jr., M.D.	133
VIII.	CONCERNING THE PRESENCE OF EMBRYOS OF TRICHINELLA SPIRALIS IN THE BLOOD OF PATIENTS SUFFERING FROM TRICHINIASIS. A. R. Lamb, M.D.	145
IX.	A CLINICAL STUDY OF THE THERAPEUTIC VALUE OF THE CALCIUM SALTS IN GASTRIC TETANY, WITH AN ANATOMICAL REPORT ON THE PARATHYROID BODIES. F. P. Kinnicutt, M.D.	155
X.	NITROGEN AND MINERAL SALT METABOLISM IN HEALTHY INFANTS. B. Raymond Hoobler, M.D.	165
XI.	THE ABSORPTION OF FOOD IN TYPHOID FEVER. Eugene F. Dubois, M.D.	175
XII.	THE CAMMIDGE REACTION IN DISEASES OF THE PANCREAS. F. P. Kinnicutt, M.D.	191
XIII.	ON HYPERTROPHY AND REGENERATION OF THE ISLANDS OF LANGERHANS. Russell L. Cecil, M.D.	199
XIV.	CONCERNING ADENOMATA ORIGINATING FROM THE ISLANDS OF LANGERHANS. Russell L. Cecil, M.D.	223
XV.	ABDOMINAL PAIN AS AN INITIAL SYMPTOM IN TYPHOID FEVER, WITH SOME STATISTICS ON ITS CAUSATION. H. S. Carter, M.D.	235
XVI.	THE OPERATIVE TREATMENT OF FRACTURES. Joseph A. Blake, M.D.	239
XVII.	THE CLINICAL FEATURES AND TREATMENT OF ACUTE GASTRIC AND DUODENAL ULCER. Ellsworth Eliot, Jr., M.D., J. A. Corscaden, M.D., and J. W. Jameson, M.D.	249

Digitized by Google

		PAGE
XVIII.	POST-OPERATIVE INTESTINAL OBSTRUCTION. George Woolsey, M.D.	313
XIX.	INTESTINAL DIVERTICULA. John A. Hartwell, M.D., and Russell L. Cecil, M.D.	343
XX.	PARATYPHOID CHOLECYSTITIS. Russell L. Cecil, M.D.	375
XXI.	ACUTE SPONTANEOUS PERFORATION OF THE BILIARY SYSTEM INTO THE FREE PERITONEAL CAVITY. Clarence A. McWilliams, M.D.	387
XXII.	ON THE LESIONS PRODUCED IN THE APPENDIX BY OXYURIS VERMICULARIS AND TRICHOCEPHALUS TRICHIURA. Russell L. Cecil, M.D., and Kenneth Bulkley, M.D.	419
XXIII.	OPERATIONS UPON THE APPENDIX. Carence A. McWilliams, M.D.	445
XXIV.	THE TREATMENT OF SPREADING PERITONITIS FOLLOWING APPENDICITIS. John A. Hartwell, M.D.	473
XXV.	ACUTE ULCER-PERITONITIS IN TYPHOID FEVER. Forbes Hawkes, M.D.	481
XXVI.	PNEUMOCOCCUS PERITONITIS. George Woolsey, M.D.	507
XXVII.	LEUKEMIC TUMORS OF THE BREAST, MISTAKEN FOR LYMPHO-SARCOMA. Clarence A. McWilliams, M.D., and Frederick M. Hanes, M. D.	521
XXVIII.	A CONTRIBUTION TO THE SURGICAL TREATMENT OF SPINAL CORD TUMORS. George Woolsey, M.D.	533
XXIX.	AN EXTRAMEDULLARY TUMOR OF THE SPINAL CORD, APPARENTLY CAUSED BY TRAUMA. David Bovaird, Jr., M. D., and M. G. Schlapp, M.D.	579
XXX.	A NEURO-EPITHELIOMA, DEVELOPING FROM A CENTRAL GLIOSIS, AFTER AN OPERATION ON THE SPINAL CORD. M. G. Schlapp, M.D.	585
XXXI.	NEW REFLEX SIGNS IN MENINGITIS DIAGNOSIS. W. P. Northrup, M.D.	605
XXXII.	THE CHILDREN'S WARD; SERVICE AND RECENT ADDITIONS. W. P. Northrup, M.D.	607
XXXIII.	AN APPARATUS FOR THE COLLECTION OF THE EXCRETA OF INFANTS. Eugene F. DuBois, M.D.	617
XXXIV.	THE BRIDDON MEDAL; CONDITIONS OF AWARD.	621

Digitized by Google

Digitized by Google

FIG. 1.—Case I.—Melanosarcoma of left eye, showing protruding tumor.

Digitized by Google

I.

VISCERAL SARCOMATA: CASES OF SARCOMA OF THE STOMACH, HEART, MEDIASTINUM, ETC.*

By W. Gilman Thompson, M. D., Late Visiting Physician.

The inoperable visceral sarcomata constitute a group of tumor cases of very great interest on account of their comparative variety, multiplicity of type and tendency to spread by metastasis. In adding five cases to the literature I have considered mainly the clinical aspects of each, with comments upon the relative frequency of similar growths, as far as the meager knowledge of the subject permits.

Case 1. *Melanosarcoma of Eye and Liver.*—The occurrence of melanotic sarcoma of the eye and liver is sufficiently rare to make the following case of exceptional value. The patient was a housewife, 34 years of age, whose heredity and previous personal history were unimportant. When first seen she presented a tumor of the left eyeball (Fig. 1) and a very large liver, in which numerous hard tumor masses were easily palpable. The eye symptoms covered a period of three years, commencing with darting pains and failure of vision in the left eye. Six months later the patient was operated upon for the result of an iritis and glaucoma. Subsequently hemorrhagic spots appeared in the sclera, and for the past year a tumor was observed protruding from the outer anterior surface of the eyeball and accompanied by much pain. Vision in the right eye remained normal. The patient's general health and nutrition were remarkably good until within a month of her admission to the Presbyterian Hospital, when she had frequent nausea with vomiting of mucus and sometimes blood, especially after eating. Examination of the abdomen revealed no pain or rigidity, but the liver, which extended almost to the pelvic brim, caused considerable bulging of the abdom-

*Read before the Practitioners' Society, February 4, 1910.

(*Reprinted from the Medical Record, April 2, 1910.*)

Digitized by Google

inal wall, over which area, as well as upon the face, there was much dark brown pigmentation in spots and plaques. Subsequently jaundice developed, there was hemorrhage from the gums, and the patient died from asthenia, with delirium, cyanosis and dyspnea. The autopsy, reported by Dr. Meakins, showed a melanosarcoma of the left eye, liver, perihepatic glands and pancreas. The spleen was normal, but the heart and kidneys presented fatty degeneration. Although there had been much hematemesis, the stomach exhibited merely a few submucous hemorrhages. The tumor of the left eye was black in color and projected at the outer side of the pupil 3 mm. above the conjunctiva. The eyeball was filled with a semi-fluid sanguineous mass. Section of the tumor revealed closely packed large, irregular spindle cells, in alveolar arrangement, but with very little stroma. Within and around the cells were masses of blood pigment.

The liver weighed 6,500 grams and measured 38 cm. in vertical diameter and 10 cm. in thickness. The transverse diameter was slightly less than the vertical. (In the accompanying photograph (Fig. 2) a normal liver is also shown for comparison. The liver stroma was nearly all replaced by tumor cells, identical in structure with those in the eye, but in parts the cells were deeply pigmented, in parts free from pigment, and in other areas there was pigment alone. Between the tumor lobules there was dense fibrous tissue. The glands at the liver hilum and along the pancreas showed similar tumor structure. The hepatic capillaries were smooth and glistening, mottled blood-red. The liver tissue appeared firm on section, but in some of the hemorrhagic areas an inch in diameter there was a semi-fluid mass. The pancreas presented small hemorrhagic nodules.

Striking features of this case were the long duration of the eye symptoms (three years), the preservation of nutrition in much greater degree than is usual with the carcinomas of the liver, and the absence of involvement of the stomach, despite the frequent hematemesis.

As the patient was not seen until within a fortnight of her death, it was difficult to determine whether the primary focus of disease was in the skin, eye or liver, but it is fair to assume that it was in the eye, for there was no history of an early pigmented growth in the skin, the eye symptoms were known to have lasted three years, and jaundice from compression did not appear until shortly before death. Moreover, primary melanotic sarcoma of the liver is almost unknown, and Hanot, in a review of the subject, could find only one authentic example. The coincident and relatively frequent involvement of the eye and liver is as obscure a morbid phenomenon as the origin of this rare form of tumor itself. Dr. N. R. Norton has lately informed me of a similar case of eye-liver association in sarcoma occurring at the Lincoln Hospital. John S. Thatcher[1] reported a case of melanosarcoma of the eye in which the liver was secondarily involved, and another of melanosarcoma of the liver alone.

Digitized by Google

FIG. 2.—Case I.—Sarcomatous liver, weighing 6,500 grams. On the right a normal sized liver is shown for comparison.

Digitized by Google

Digitized by Google

Hirschberg (*Berl. klin. Woch.*, 1905, Nos. 4 and 5) reported two cases of melanosarcoma of the eye in which metastases were first observed in the liver fully 9 years later.

CASE II. *Lymphosarcoma of Mediastinum.*—The following fulminating case of lymphosarcoma illustrates the rapidity with which the disease may become fatal. The patient was a remarkably robust lad of 19 years, employed

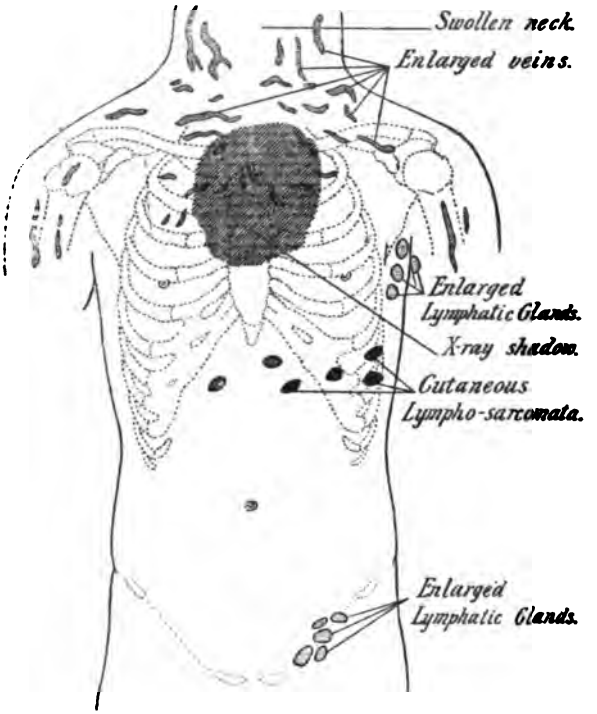


FIG. 3.—Case II.—Lymphosarcoma of mediastinum.

as a truck driver, who died within a month of the outset of symptoms and remained at work until a fortnight before death. He first noticed a diffuse uniform swelling of the face and neck, and fullness in the head with dry cough and slight dysphagia. There were no other subjective symptoms of any kind until within an hour of sudden death. On admission to the Presbyterian Hospital the patient's neck was symmetrically swollen, evidently as a result of venous congestion. The superficial veins of the neck, upper sternal region, shoulders and upper arms were greatly swollen and tortuous on both sides. In the left axilla and groin were a few moderately enlarged lymphatic glands. Across the lower thorax anteriorly were a half dozen red elevated plaques, about an inch in diameter, resembling urticaria, and in fact the

Digitized by Google

eruption was mistaken for urticaria by a dermatologist who first saw
I noticed, however, that although the redness disappeared on press
swellings seemed firmer than the usual urticaria wheels, and in co
with the swollen lymph glands and mediastinal pressure, I regarded
as one of probable lymphosarcoma, and directed the house physician
T. Roome, to excise one of the cutaneous tumors for microscopic exan

Meanwhile the X-ray (Fig. 4) showed a heavy shadow in th
mediastinum, through which masses resembling enlarged glands c
differentiated. There were no pulmonary symptoms other than an
dullness corresponding with the shadow, and a tracheal compression
breathing. The cough was brassy, like the laryngeal cough of ar
There was no fever, and the blood count was practically normal, as
Hemoglobin, 95 per cent.; erythrocytes, 5,268,000; leucocytes, 11,600;
clear cells, 66 per cent.; lymphocytes, 23 per cent.; mast cells, 1 per
was easy to exclude a diagnosis of aneurysm, abscess, tuberculosis,
and other types of mediastinal growth than the one suspected.

The pathological examination by Dr. Opie and Dr. Cecil of the
tumor was as follows: "The tumor measured 10 x 6 x 3 mm., was
to the skin, and had a leathery consistence. The corium was greatly i
in thickness and infiltrated with cells of lymphoid type, occurring
masses and scattered form. There were karyokinetic figures and i
nuclei; the subcutaneous tissue was infiltrated with masses and str
lymph cells, the largest being grouped about the sweat glands.
areas were eosinophiles. Diagnosis: lymphosarcoma."

On showing the section of the skin tumor to Dr. Ewing, he ex
doubt as to the possibility of classifying it accurately, the specimen pr
some suggestion of an epithelioma or alveolar sarcoma.

The patient felt so well that he was permitted to sit in a chair,
was suddenly seized with intense gasping dyspnea, cyanosis, and ar
ceptible pulse. Thinking the dyspnea was in part due to laryngeal p
Dr. Roome intubated the patient and gave vigorous heart stimulation,
patient died from loss of breath within an hour. Unfortunately for
plete clinical picture, no autopsy could be obtained, so it was impos
determine the number and size of the mediastinal glands involved
as they may partially be determined by the radiograph. The manner
resembled that from enlarged thymus in childhood, and the thymus h
found involved in similar cases. The case is unique from the rapid
course and the restricted development of secondary foci outside
mediastinum.

The literature of mediastinal sarcomata is necessarily meager. In
classical monograph on mediastinal growths[2] he excluded cases of
reported prior to 1870, owing to the imperfect technique prevailing
that date, but collected 98 cases reported in the succeeding nineteen

Digitized by Google

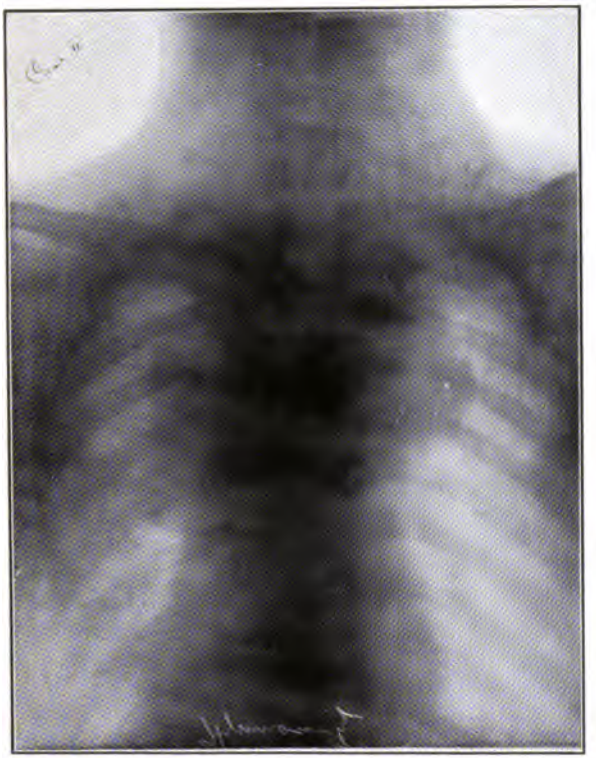


Fig. 4.—Case II.—Radiograph, showing thickening of neck, and extensive shadow in upper anterior mediastinum.

Digitized by Google

Digitized by Google

Among a total of 520 cases of mediastinal growths, nine of the sarcomata occurred in the second decade of life. Eight years later Irving S. Haynes[3] collected 18 more cases for an article in the Loomis-Thompson System of Practical Medicine.[3]

Almost all the lymphosarcomata of the mediastinum are primary. They are of very rapid development, and usually involve the anterior mediastinum, originating in the thymus or tracheo-bronchial lymph nodes. Haynes suggests that the foreign material absorbed from the lungs or bronchi after inhalation and conveyed to the lymph nodes may prove an exciting cause by irritation. Sarcoma is the most frequent variety of histogenetic tumor occurring in the mediastinum, outnumbering the carcinomata three or four to one. The latter tumors, moreover, usually involve the posterior mediastinum, where there are more varieties of tissue from which they may develop, and they grow more slowly than the sarcomata, giving time for constitutional symptoms to arise. The case above reported corresponds in the site, rapidity of growth and absence of constitutional symptoms with these observations. Excepting the obvious swelling of the neck, the patient looked and felt almost perfectly well until within the hour of his death.

Case III. *Melanosarcoma of Skin, Lungs, Heart, and other Organs.*—In contrast with the few secondary growths in the previous case, is that of a woman still under observation, who with sarcomata of the lung presents 185 tumors of the skin and superficial lymph nodes. Her history, in brief, is as follows: The patient is an Austrian, 40 years of age, formerly employed in a clothing manufactory. She was in good health until within nine or ten months of her admission to the Presbyterian Hospital. For many years she had had a dozen small, black pigmented moles distributed over the dorsal surface of both feet and the lower part of the abdomen. One of these, on the left foot, became bruised and irritated by scratching, so she had it removed. Shortly afterward she noticed a bunch of about a dozen nodular tumors extending downward in the left femoral region. These were also excised. A few months later numerous subcutaneous nodules began to appear all over the body, which gave gone on multiplying and increasing in size, most of the 185 having appeared within a period of two months. They vary in size from a diameter of half an inch to two inches. They are most prominent over the lower thorax, both groins, middle of the back and both arms, but there are few areas of the surface larger than half a dozen inches in diameter where some may not be found. The larger nodules cause considerable elevation of the surface of the skin, but the skin appears movable over them. A few are somewhat bluish in appearance, but none are deeply pigmented. From time to time there is local pain over groups of nodules, but it is neither constant nor very severe. The nodules are painful when first appearing, but the larger growths are neither painful nor tender.

Digitized by Google

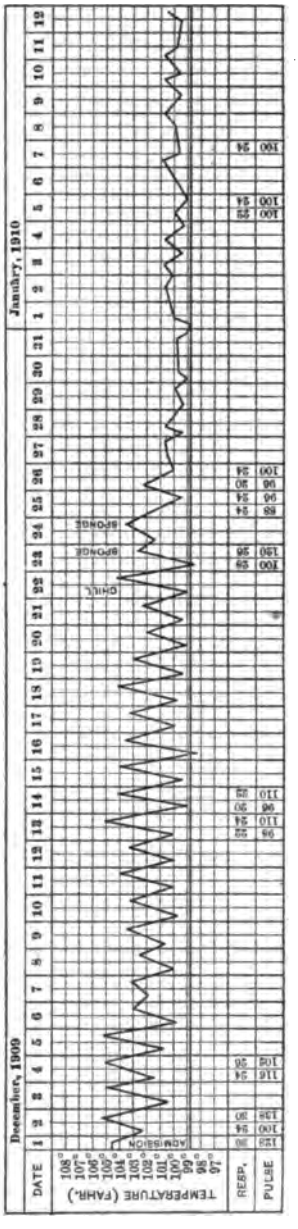


FIG. 5.—Case III.—Septic type of fever with universal sarcoma.

Digitized by Google

Digitized by Google

FIG. 6.—Case III.—Radiograph, showing combined atelectasis and consolidatio
sarcoma nodules of entire left lung.

Digitized by Google

During the past few months the patient has lost about thirty pounds in weight, and has complained of progressive weakness, fever, sweating, occasional vomiting, cough with bronchial expectoration (sometimes blood tinged) and occasional pain in the left chest, with a sensation of fullness there. She has also had chills at intervals. The examination of the urine, sputum and blood cultures are all negative. For a month after admission to the hospital the patient exhibited an abruptly septic type of fever, with daily fluctuations of about 4° Fahrenheit and a maximum rise to 105° Fahrenheit. (Fig. 5.)

Explanation of this temperature was sought in the possible breaking down of one of the sarcomatous nodules, but none could be found, and the only demonstrable visceral involvement is in the left lung, which appears solid from the base to above the angle of the scapula. A radiograph (Fig. 6) shows this portion of the lung to be absolutely air free, aspiration gives a negative result, and the physical signs are those of dense consolidation over this same area in which the patient has complained of pain and oppression. All the other viscera appear normal. The only adequate explanation of the prolonged high septic temperature would appear to lie in some disturbance of metabolism connected with the very rapid dissemination of so many new growths, but it was not accompanied by marked emaciation. In other reported cases of this type no mention is made of such a phenomenon, but it is well known that a similar irregular fever may occur during the course of Hodgkin's disease.

Blood examination is as follows: Hemoglobin, 67 per cent.; red cells, 4,840,000; leucocytes, 25,800; polynuclear cells, 82 per cent.; transitional, 2; large mononuclear, 5; lymphocytes, 9; basophiles, 0.5; eosinophiles, 1; many plates. The last day of December, 1909, the patient attempted to get out of bed unaided and fractured the neck of the right femur. As the violence was trivial, the accident suggested abnormal brittleness of the bone. A partial fracture was demonstrated by the X-ray. (Autopsy showed the fracture to have been due to a metastasis in the bone.)

Previous to entering the hospital the patient had some sort of serum treatment, the nature of which could not be determined, but the result was negative. I asked Dr. William B. Coley to see the patient, and he was of the opinion that the case was of melanotic type, and not amenable to treatment by his serum. I had a subcutaneous nodule removed by Dr. Roome, and Dr. Cecil, of the pathological department of the hospital, reported that it was a neoplasm composed of round cells closely packed and supported by a scanty stroma. Blood vessels were found in intimate contact with the tumor cells.

The face and the feet are the sites from which melanomata of the skin most often arise. J. A. Fordyce[4] reports two cases originating from the foot, although he believes that the pigmented congenital mole is not a necessary antecedent of melanomata, for some of the latter appear without such association, and pigmented moles are exceedingly common in comparison with the rarity of melanoma. The case above reported illustrates again the well-known fact that metastases of melanomata are more numerous than those of any

Digitized by Google

other type of cutaneous malignant tumor, although they are not invariably present in the skin in cases of visceral melanotic sarcoma. Thus none were observed in the eye-liver case above reported (Case I), although the disease had lasted two or three years. The reason for the rapid spread of the metastases sometimes seen in melanoma appears to be dissemination through both blood and lymphatic channels. The original idea that the melanin is derived from blood pigment is controverted by the fact that iron is absent, whereas sulphur is present in the dark amorphous granules, and another explanation which has been offered is that some form of nuclein becomes altered into pigment. Not all the cutaneous tumors contain pigment, whereas some are filled with it. In the case above cited the general appearance of those tumors which are nearest the surface varies from white to a distinctly bluish color, and in the specimen excised for examination no pigment was observed. This variation accords with the usual finding in similar cases whch have been reported.

The disastrous result which so closely followed upon the removal of a pigmented mole in this case emphasize again the well-known possible danger of this procedure, and is a strong argument in favor of treatment by radium, according to Dr. Abbe's method.*

**Since writing the above description the patient died. Autopsy by Dr. Cecil showed an extraordinarily wide distribution of hard white sarcoma nodules, varying in size from a pea to several inches in diameter, which were of non-pigmented round-cell type. The spleen and liver curiously escaped, but nodules were present in their capsules, as well as in the pleura, bronchi, heart, pericardium, diaphragm, kidneys, suprarenals, thyroid, stomach, intestine peritoneum, abdominal lymph nodes pancreas, ovaries, and bone marrow. The appendix was a mass of nodules, yet there were no symptoms of appendicitis. The destruction of the suprarenals gave rise to no bronzing of the skin. The nodules in the heart involved the septum auriculorum, and projected into the right auricle.*

Case IV. *Sarcoma of Stomach, Heart, and Kidneys.*—This was the case of an Irish woman, 47 years of age, who was in good health to within two months of her death, when she suddenly complained of abdominal, especially epigastric, pain, frequent nausea and vomiting, and weakness. Despite these symptoms she was able to perform housework until within ten days of her death, although she lost about 25 lbs. in weight. There was no hematemesis or jaundice. The patient lived only four days after admission to the Presbyterian Hospital, during which time she had frequent vomiting, constipation, slight dyspnea and edema of the feet. The vomitus contained much mucus, with bile, pus cells, and red blood corpuscles. No hydrochloric acid was found, either free or combined. The urine was of low specific gravity—1009—and contained red blood corpuscles, fat cells, and a trace of albumen, but no casts. There was decided secondary anemia, the hemoglobin measur-

Digitized by Google

ing 64 per cent. The leucocyte count was 9000, with 68 per cent. polynuclear cells and 26.5 per cent. lymphocytes. Examination of the large, flabby abdominal wall showed no rigidity or tenderness, but both kidneys were very large and palpable, the right one being markedly prolapsed. Palpation over the epigastrium gave the impression of a deep-seated mass, and the diagnosis of gastric carcinoma seemed justified. The patient died from exhaustion, and the suspected carcinoma turned out to be a sarcoma of the stomach associated with extensive secondary growth in the heart, kidneys, pancreas, ileum, colon, and mesenteric glands. The following is abstracted from the report of the autopsy by Dr. Cecil. The tumor mass in the stomach was hard, white, homogeneous and glistening and composed of small closely packed lymphocytes in a delicate fibrous stroma. It largely replaced the mucosa, and, in part, had ulcerated through it. The few remaining glands of the mucosa were atrophic. There were a few minor tumor nodules. In the ileum and colon were small flat tumor masses, oval, which in some cases appeared to occupy the Peyer's patches as well as to replace the mucosa. There were also necrotic areas. Microscopically the intestinal tumors comprised the same closely packed lymphoid structure as the stomach tumor. The heart weighed 385 grams, the valves and pericardium were normal, but in both ventricular walls were seen many smooth, pinkish, oval tumor masses about 2 cm. in diameter, without very distinct margins. Microscopically the tumors comprised the same type of lymphoid cells seen elsewhere, which were found to pack the intermuscular spaces and separate the muscle fibrillæ. The latter appeared intact despite the density of the new growth, which fact, in a measure, explains the remarkable absence of cardiac symptoms while the growth was in process of development. In certain other reported cases of sarcoma of the myocardium, a similar absence of symptoms has been commented upon.

The kidneys were very large, the right weighing 390 gm. and the left 430 gm. The capsules were nonadherent, and the normal kidney tissue appeared entirely replaced by nodules and irregular glistening white conglomerations of lymphoid cells. Many tubules and glomeruli were destroyed, others showed epithelial desquamation and distention with hyaline substance. The liver, spleen and suprarenals were normal.

The infrequency of occurrence of sarcoma of the stomach may be gathered from a study made in 1905 by Corner and Fairbanks[8] of London, who collected 175 cases from the literature of primary sarcomata of the alimentary canal, of which 58 involved the stomach and 65 the small intestine. About one-third of these growths were of round-cell structure. Subsequently Norman Dalton[9] reported a round-cell sarcoma in-

Digitized by Google

volving primarily the stomach and abdominal lymph nodes in a boy 15 years of age.

Harlow Brooks[7] reported in 1905 four cases of primary sarcoma of the stomach, one of which was of round-cell type, one a fibrosarcoma and one an agiosarcoma. His conclusion that sarcoma, while it is less apt than carcinoma to involve the gastric mucosa, is also less liable to form metastases, does not appear valid in view of the findings of the other cases herein quoted.

Sarcoma of the Heart has been less often observed than carcinoma, when the total number of cases of each are compared, but although sarcomata in general are less common than carcinomata, the relative proportion of sarcomata in the heart is somewhat greater. All varieties have been found in the heart, and although all are rare, the melanotic, round cell and lymphosarcomata are most often encountered. Less often cases have been recorded of the spindle cell, fibro-- myxo-, and osteo-sarcoma types, together with various mixed and doubtful varieties. As a rule the growths are secondary, but about a score of primary tumors have been reported, although in many of the latter cases the autopsies have not appeared complete as to microscopic details of other organs.

Curt Boether,[8] in an inaugural dissertation for the doctorate in 1897, tabulates 31 published cases of sarcoma of the heart, mostly from German sources, including four of melanotic type. They involved collectively all parts of the heart, two affecting the tricuspid valve.

Boruch Blumensohn[9] of Russia, in an inaugural dissertation for the doctorate in 1907, refers to 10 published cases of primary sarcoma of the heart, and a somewhat longer list of secondary growths, to which he adds 12 cases from the Patho-

Digitized by Google

logico-anatomical Institute of Basel, four of which were melanosarcomata. In six cases the valves were involved.

Ludwig Hektoen[30] has figured a remarkable spindle-celled sarcoma of the right ventricle, secondary to a growth in the tibia, occurring in a lad of 12 years.' In the same article he reports a primary round-cell sarcoma of the epicardium, and another case of a melanosarcoma of the right ventricle secondary to a growth in the breast.

A. Jacobi reported a case of fibrosarcoma of the heart, and S. W. Gross, one of round-cell type.

Epstein[31] reported the case of a male, 22 years of age, who presented a sarcoma of the stomach with secondary nodules in the kidney and a degenerated sarcomatous mass lying between the right auricle and ventricle.

E. Bonardi[32] reported a case of sarcoma of the heart secondary to a melanosarcoma of the choroid.

B. Luzzato[33] was able to make a correct diagnosis of a sarcoma of the heart secondary to growths in the leg and lung, owing to the supervention of a mitral stenosis while the patient was under observation. The diagnosis, which has rarely, if ever, previously been made correctly, was confirmed by autopsy.

Charles Norris described a case of melanosarcoma of the heart in a boy of 16 years which accompanied similar growths in the skin, kidneys, and liver.

The late H. P. Loomis[34] reported a case of diffuse round-cell sarcomatous infiltration of the heart and kidneys, secondary to a sarcoma of the breast, which was not unlike the personal case I have above detailed. (Case IV.)

Digitized by Google

Peter Neu[15] reported a lymphosarcoma of the left ve
"as large as an apple," apparently secondary to the
of a tonsillar growth and complicated by cerebral emb

Alexander Lambert[16] has described the case of a
years of age, in which a small round-cell sarcoma invol
lung, pleura, pericardium, and left ventricle, which
markable from the fact that the patient was able t
shovelling snow until within a month of his deat
dyspnea. The rapidity of development of this growth is
gous to that in Case II, above described.

John S. Thacher's[17] case was one of small round-c
involving the stomach, with a secondary growth in
auricle.

E. Libman[18] described a lymphosarcoma of the smal
tine, the only one among 60 recorded cases in which the
metastases in the heart muscle.

Karl Bodenheimer[19] (Inaugural Dissertation) rep
case of primary sarcoma of the heart from the Bern K

Byron Bramwell[20] pictures a large double sarco
growth of the heart, one mass lying upon the exterior
right ventricle, beneath the pericardium, the other
within it, below the tricuspid valve.

The sarcomatous nodules may be situated within t
cardium, as in Case IV herein reported, or lie upon
Case III, or beneath the endocardium, but are less liab
carcinomata to involve the pericardium unless by ex
from mediastinal growths. The pericardium may, h
become affected separately, and Kaak has reported (
myxocystosarcoma occupying this site. The usual per
growth takes the form of a diffuse infiltration.

Digitized by Google

A striking feature of all the reported sarcomata of the heart is the infrequency of associated embolism and cardiac rupture.

To this list I add the two cases above reported (Cases III and IV).

CASE V. *Small Round-Cell Sarcoma of Stomach.*—The following case of lymphosarcoma of the stomach was operated upon by the late Andrew J. McCosh at the Presbyterian Hospital, and has not previously been reported.

The patient was a housewife, 39 years of age, who for a year had complained of gastric symptoms, mainly pain and vomiting, accompanied by loss of weight. Melena was present, and free hydrochloric acid was absent from the stomach contents. A mass of considerable size could be palpated in the epigastrium. A gastrectomy was performed, when the mass, which was the size of an egg, was found to occupy the pyloric end of the stomach, extending into the greater curvature. No secondary nodules were discoverable.

The tumor mass removed from the stomach measured 6 x 4 cm. It was hard and glistening, and composed of small round cells, larger than lymphocytes, imbedded in a small amount of stroma. The mass destroyed the submucous coat, and remains of the muscular coat were distributed through it. There was much lymphoid tissue also in the muscular coat, and the neighboring mucous membrane presented many ecchymoses.

Virchow[11] in his classical work, "Die krankhaften Geschwülste," stated the general proposition that "almost all those organs which show a great predilection for malignant tumor formation have little tendency to beget metastases, and conversely," yet the visceral sarcomata present so much variation in metastasis that it would seem unwise, with our present knowledge, to apply any such general rule to them.

Most of the 43 sarcomata received into the Second Division service of Bellevue Hospital during the past five years were sent in for operation, and the tumors of this group showed the usual predilection for the jaw, pelvic bones, and thigh.

Digitized by Google

There were also seven cases involving lymph nodes in the neck, but in none of these latter, although the growths were multiple, was there any tendency to visceral or cutaneous metastases. One visceral case involved the kidney and one the occipital lobe of the brain, without metastases. The occipital tumor was as large as an orange, and caused blindness, deafness, headache, vomiting, convulsions, and noisy delirium. There was one case of lymphosarcoma of the intestine in a patient 53 years of age, but there was no involvement of the other viscera or skin. In two cases the tumor was situated in the right orbit, without extension to the liver or other organs. There were two cases of melanosarcoma of the skin with multiple growths which were very numerous. They were also without metastases, apart from the skin, at the time at which they were under observation. One of these cases involved the trunk and lower extremities, the other the trunk and upper extremities. The latter case was that of a man 50 years of age, who had cauterized a pigmented mole. Six months later a nodule appeared beside the umbilicus and was excised, when five months later the tumors became generalized throughout the skin. This series of cases emphasizes the comparative infrequency of visceral metastases, even when the local growths had attained to considerable size, whereas in the four cases of my personal series, the visceral extension was the most serious part of the disease. As they belong to different species of sarcomata it is interesting to observe the extent of the involvement. That there did not happen to be any visceral metastases in the Bellevue series is doubtless due to the fact that the patients in many instances came in for early operation, before the disease had spread.

Digitized by Google

REFERENCES.

[1] Thacher, John S.: Proc. N. Y. Path. Soc., 1893, p. 105.
[2] Hare, H. A.: Diseases of the Mediastinum," 1889.
[3] "Loomis-Thompson System of Practical Medicine," 1897, Vol. II, p. 615.
[4] Fordyce, J. A.: Jrn. Amer. Med. Assn., Jan. 8, 1910.
[5] Corner and Fairbanks: "Trans. London Path. Soc.," 1905.
[6] Dalton, Norman: "Trans. London Path. Soc.," 1907, p. 61.
[7] Brooks, Harlow: Med. News, July 15, 1905.
[8] Boether, Curt: Inaugural Dissertation, Berlin, 1897.
[9] Blumensohn, Boruch: Inaugural Dissertation, Basel, 1907.
[10] Hektoen, Ludwig: Med. News, Nov. 18, 1893, p. 571.
[11] Epstein: Archives de méd. et de pharmacie militaire, Dec., 1892.
[12] Bonardi, E.: "Estratto di Rendiconti del R. Istitute Lomb. di sci. e lett," Serie II, Vol. 38, 1905.
[13] Luzzatto, B.: "Trat. italiano di patologia," Vol. IV, p. 315.
[14] Loomis, H. P.: "Proc. N. Y. Pathol. Soc.," 1892, p. 82.
[15] Neu, Peter: Dissertation zum Doctorexamen, Bonn, 1893.
[16] Lambert, Alexander: "Trans. Assoc. of Alumni of Bellevue Hosp.," 1897, pp. 18-25.
[17] Thacher, John S.: "Proc. N. Y. Path. Soc.," 1895, p. 101.
[18] Libman, E.: "Proc. N. Y. Path. Soc.," 1904-05, p. 131.
[19] Bodenheimer, Karl: Inaugural Dissertation.
[20] Bramwell, Byrom: "Diseases of the Heart," p. 655.
[21] Virchow: "Die krankhaften Geschwülste."

Digitized by Google

Digitized by Google

II.

THE ELECTROCARDIOGRAM IN CLINICAL MEDICINE.*

By WALTER B. JAMES M.D., VISITING PHYSICIAN,
and
HORATIO B. WILLIAMS, M. D.

I. THE STRING GALVANOMETER AND THE ELECTROCARDIOGRAM IN HEALTH.

The ability to record the changes in potential of the heart muscle which accompany its activity gives us an entirely new point of view of the normal and morbid action of the heart, and promises to throw new light upon the many problems presented by the physiology and the pathology of the organ. It is little wonder, therefore, that a considerable interest has rapidly developed in electrocardiography, and that even in the short time that has elapsed since it was first demonstrated a fairly voluminous literature of the subject should have accumulated. It is the purpose of the present paper to describe as briefly as possible, and with as few technicalities as may be consistent with clearness and accuracy, the principles of electrocardiography and its practice and the results that we have obtained with it in the course of the last winter.

An electrocardiogram is a graphic record of the action current of the heart muscle, and is obtained by leading this very

(*Reprinted from the American Journal of the Medical Sciences, September and November*, 1910.)

Digitized by Google

feeble current to an exceedingly sensitive galvanometer, the excursions of the moving part of which are permanently recorded by throwing its shadow upon a moving strip of photographic film. For many years it has been a fact well known to physiologists that every muscle contraction has associated with it certain definite and interesting changes of electrical potential. Thus, the piece of muscle becomes essentially a feeble galvanic cell in which the active portion corresponds to the zinc plate, the passive to the copper, and when the two are connected the current which passes is called the action current of the muscle. The fundamental fact which must always be borne in mind in the study of the electrocardiogram is that the surface of that portion of a muscle which is active is negative to all the rest of the surface, which is positive.

If we take a piece of muscle, *A*, *B*, *C* (Fig. 1), apply electrodes *E*, E^1, connect these by wires to a galvanometer *G*, and then stimulate the muscle at *A*, a wave of contraction begins at this point, and this electrode becomes negative to E^1, which is positive, and the needle *G* shows a corresponding variation. When the wave of contraction reaches the middle point *B*, the potential of *A* and *B* now being the same, no current passes and the needle returns to the zero point. The wave now passes toward *C*, which in turn becomes negative to *A*, and the needle is deflected in the opposite direction.

Fig. 2 represents diagrammatically the curve obtained by passing the action current of a simple muscle contraction through the string galvanometer. At *A* the contraction wave passes the first electrode, at *B* it is midway between them, and at *C* it has passed beyond the second electrode. This record is a graphic representation of what is called a diaphasic variation, and this type of curve will be referred to later in connection with certain phenomena met with in cases of disease.

Digitized by Google

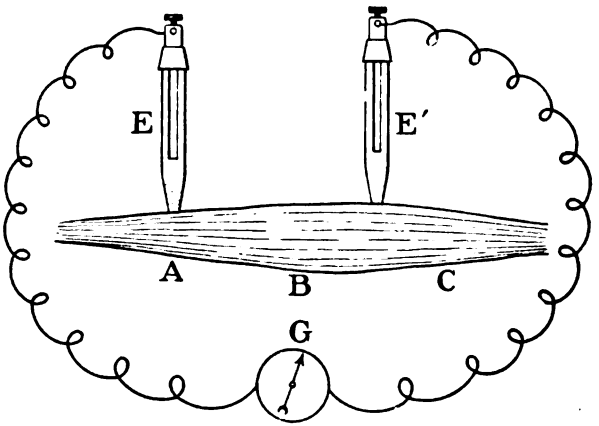


FIG. 1.—Scheme to illustrate the action current of a simple muscular contraction.

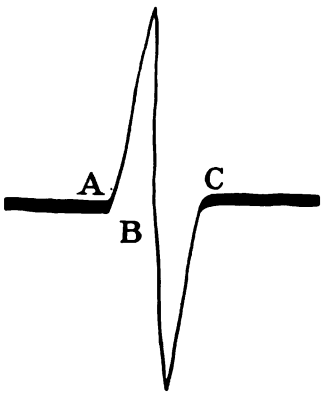


FIG. 2.—Scheme of a diphasic variation accompanying a simple muscle contraction.

Digitized by Google

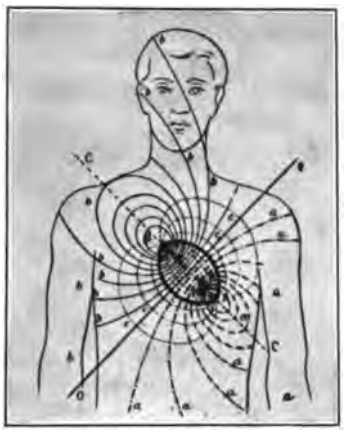


Fig. 8.—Lines of diffusion of the action current of the heart (after Waller).

Digitized by Google

In 1856 Kölliker and Müller[1] succeeded in detecting the action current of the frog's heart by applying electrodes to its surface, and so proved that this current is obtainable. In 1887 A. D. Waller,[2] using the capillary electrometer and applying his electrodes to various portions of the surface of the human body, succeeded in recording the curve of the action current of the human heart and demonstrated some of its characteristics. He studied and compared the curves obtained by leading the currents from various parts of the surface of the body, and so attempted to establish the lines of diffusion of the heart's action current, and published a diagram embodying his conclusions, of which Fig. 3 is a reproduction. He concluded that the most useful leads were those from the right arm and left leg. Waller's diagram, while it gives a general idea of the current diffusion, yet in its details has been proved by later researches and by using more satisfactory apparatus than was at that time at his disposal, to be far from an accurate and full representation of the facts.

Up to the present no complete and satisfactory study of the lines of diffusion made with the aid of modern instruments has appeared. Owing to the feebleness of the currents and to the unsatisfactory nature of the instruments in use, it was not supposed that the action current would ever be used as a practical aid by the clinician, and physicians took but scant interest in it. Indeed, the existence of muscle action currents, though taught and demonstrated in the early years of the medical curriculum, has, as a rule, been forgotten by practitioners. Waller[3] himself has recently said that when he made his first observations he did not imagine that they would ever be of practical value to the physician.

The capillary electrometer used by Waller and the other early investigators had numerous disadvantages. While very

Digitized by Google

sensitive and completely aperiodic, it was too slow in its response to give a faithful record of changes of potential as rapid as those taking place in the heart, and its difficulty of manipulation and its liability to become disordered made it, on the whole, an unsatisfactory instrument, except in the hands of a trained physicist and one willing to devote a great deal of time to it. Morever, by reason of its slowness of response, the curves obtained by it had to be subjected to a mathematical reduction before they could be interpreted.[4]

For all of these reasons Professor Einthoven,[5] of Leyden, was led to undertake the construction of a more satisfactory instrument. Taking the well-known Deprez-d'Arsonval galvanometer as a starting point, and considering the mathematical formula which expresses its factor of merit, he was led to reduce the weight of the moving part to a minimum and increase the strength of the magnetic field, and so ultimately elaborated what is to-day known as the Einthoven string galvanometer (Ger., Saitengalvanometer). The principle upon which it operates is as follows:

Whenever a current of electricity passes through a magnetic field at right angles to the lines of force, it tends to be deflected to one side or the other, according to its direction. If we stretch a conductor between the poles of a magnet at right angles to the lines of force, it will tend to be deflected when traversed by a current, the direction of the deflection depending upon the direction of the current. Einthoven constructed a powerful electromagnet, through the field of which he stretched a very delicate fiber, which was either a fine platinum wire or a quartz thread which had been silvered to render it a conductor. The diameter of the finest strings measures as low as 2.5 μ or about 1/3 the diameter of a red blood corpuscle, and they are invisible to the naked eye except in a strong light.

Digitized by Google

The mass is so small that it is unweighable. A micrometer screw enables the operator to increase or diminish the tension of the string at will, and so vary the sensitiveness of the instrument. An arc light operating in connection with a system of condensing lenses, and an objective and projection ocular project the shadow of the string upon a screen, the varying of the distance of which enables one to secure any magnification that may be desired. A standard cell of constant electromotive force in connection with a system of plug rheostats enables the operator to send any desired current through the string, and so, by varying the tension of the string its sensitiveness may be made to conform to any desired standard.

Following the standard established by Einthoven and now in general use, it is customary so to adjust the instrument that the shadow moves one centimeter when a difference of potential of one millivolt is applied to the terminals of the string. It cannot be too strongly urged upon those making electrocardiograms to adopt and follow the standard suggested by Einthoven, as this enables curves made in various laboratories to be compared readily. The quickness of response is such that no mathematical revision of the curve is necessary, and within fairly wide limits the excursion of the string is directly proportionate to the voltage, so that the curve can be used not only to study the direction of the current, but to study its voltage quantitatively. If electrodes are applied to any part of the body it is found that differences of potential regularly exist which give rise to currents. These are probably the sum of the minute currents resulting from the glandular activities of the body, especially of the skin, and they develop a current of very considerable strength. This current, which varies in individuals and in the same person at different times, is called the skin current (Dubois-Raymond[9]).

Digitized by Google

In taking an electrocardiogram the skin current produces a deflection of the string, and must be exactly compensated by throwing into the circuit, in the opposite direction, an equivalent amount of current from a cell. It is desirable that the patient be as nearly as possible in a state of absolute relaxation, and he must be cautioned not to move or to allow any of his muscles to be in a state of tension. A suddent violent action of muscles may produce such a change of potential as to break the string. We have found it best to have the patient lying on his back on a bed, with the head and shoulders slightly raised.

It is not necessary that the subject should be near the instrument. We have the wards of the Presbyterian Hospital connected with the laboratory by a system of wiring which permits the taking of any patient's electrocardiogram without removing him from his bed. Einthoven[1] connected the hospital with his physiological laboratory, about 1.5 kilometers distant, and secured records in this way, calling them telecardiograms. It is necessary to adjust the wiring so that there shall be no induction from neighboring telephone and other electric circuits. Most of our records are telecardiograms. The chief advantages of this method are the saving of time and labor for the operator, the additional convenience and comfort of the patient, and the additional chance of obtaining records free from evidence of voluntary muscle tension.

Different types of electrodes are used by various observers, but they consist almost always of a vessel containing a solution of sodium chloride into which the limb is put, though sometimes non-polarizable electrodes are used. We have obtained our best results with electrodes devised by us, which consist of a large, thin, flexible sheet of German silver covered with thin felt. These are dipped in hot salt solution and bound about the extremities by tapes. These electrodes give an al-

Digitized by Google

Digitized by Google

FIG. 4.—The electrodes in use.

FIG. 5.—Complete apparatus for obtaining electrocardiograms.

Digitized by Google

most constant difference of potential of about half a millivolt, so that they may for clinical purposes be regarded as normal electrodes. The resistance of the electrodes themselves is exceedingly small, being about 2.8 ohms for the pair, and we have uniformly found the resistance of the patient's body, together with these electrodes, not greater than when the tanks furnished by Edelmann are used. Fig. 4 shows these electrodes in use. It is customary to estimate and record the body resistance just before the record is made, and this is generally from 200 to 500 ohms. The resistance is determined by a Wheatstone bridge and telephone.

The movements of the shadow of the string in response to the action currents of the heart are recorded permanently by any satisfactory photographic registering apparatus, to which a timing device is attached which also casts its shadow upon the moving film. Our records were all made with Edelmann's large galvanometer with the complete accessory appliances as supplied by him, including a registering apparatus driven by an electric motor, the time being recorded either by a Jacquet timer giving fifths of a second, or by a Zimmerman spring timer beating tenths.

The apparatus is erected in a special laboratory in the Presbyterian Hospital, and is shown complete in Fig. 5, which, however, does not show the mounting of the galvanometer subsequently adopted to eliminate vibration. The proximity of the hospital to electric car lines has made the problem of eliminating vibration a difficult one. While the string galvanometer is far less sensitive to vibration than most types of galvanometers, a complete absence of vibration would be very desirable. At the time the curves presented in this paper were recorded, we had not succeeded in entirely eliminating such vibrations, but they can in every case be fairly readily distin-

Digitized by Google

guished from waves produced by variations of electrical potential.

The character of the curve is found to vary with the parts of the body from which it is led off. It is found advisable to take at least three different leads in each case, and, following Einthoven, these are termed I, II, III, and are as follows:

I. Right arm and left arm.
II. Right arm and left leg.
III. Left arm and left leg.

The records obtained from these three leads show certain characteristic differences, which will be described a little later.

In order to bring out certain features of special cases, any two points on the body whatever may be used as leads, but it is desirable, in order that the results of different observers may be compared, that at least the three standard leads should be used in every case. The steps necessary to be taken, then, in making an electrocardiogram are as follows:

1. The attachment of three electrodes to the patient.
2. The establishment of the sensitiveness of the galvanometer at the standard point and the making of a control curve.
3. The estimation of the resistance in each of the three leads.
4. The compensation of the skin current.
5. The recording of the string movements caused by the heart's action current which now become apparent.
6. The developing and printing of the film, which it must be remembered is not a negative, but a positive.

In spite of the apparent complexity of the procedures above described, we have found that the time required to make a complete set of three records, one from each lead, exclusive of the time taken in attaching the electrodes to the patient and in developing and printing the film, was generally from three

Digitized by Google

Digitized by Google

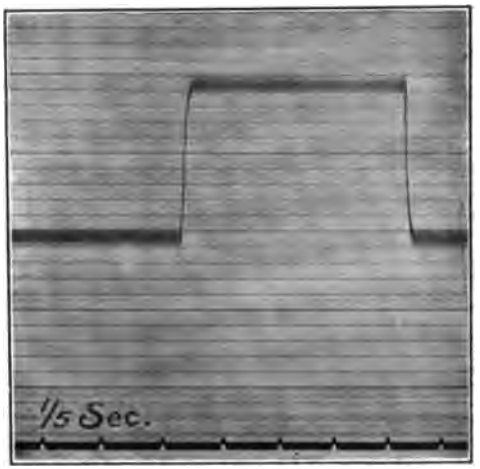


FIG. 6.—Control curve.

Digitized by Google

to five minutes. There are certain possible sources of error which should be borne in mind by the operator, the chief among which we have found to be the following.

1. Mechanical vibration due to instability of foundation. The conditions will naturally differ in each equipment, and the difficulties must be met and overcome according to the indications. Our galvanometer stands upon the floor of a fireproof hospital pavilion on the second floor, and through the building receives a certain periodic vibration. This we have largely obviated by standing the instrument on sand contained in a large box.

2. Induction from outside sources.

3. Defective insulation.

4. Induction caused by hissing of the arc lamp as explained by Rothberger and Winterberg.[9]

5. Tenseness of the patient's muscles, which gives rise to a fine vibration of the string (Einthoven[10]) at the rate of 50 per second (Piper[11]).

6. Gross muscular movements, such as coughing or sneezing, which cause large irregular movements of the string, which can be readily distinguished from those due to the heart's action.

To insure the proper working of the galvanometer and to guard against the presence of misleading induction effects or mechanical vibration, it is advisable to precede the taking of every record by the recording of a control curve.

Fig. 6 is such a curve, obtained by applying to the string terminals a difference of potential of 2 millivolts. This may conveniently be done at the time the sensitiveness of the instrument is adjusted, and gives a permanent record of the sensitiveness for that particular record. Such control curves have been taken for the greater number of our records.

Digitized by Google

The satisfactory interpretation of all the elements of the normal electrocardiogram is not yet possible, but its principal features can be explained, and correspond to definite events in the cardiac cycle. Fig. 7 represents diagrammatically a "normal" electrocardiogram in which the various waves have been lettered according to the system originally suggested by Einthoven. Fig. 8 is an electrocardiogram taken from a healthy individual while sleeping, and shows the curve obtained with each of the three leads. It is in the highest degree desirable that this nomenclature should not be departed from without the best of reasons, as failure of uniformity causes an enormous increase in the difficulty of comparing records, a difficulty which is already considerable. Certain observers have already adopted a different lettering upon grounds that seem inadequate, and have thus added greatly to the labor of reading and understanding their communications.

The normal record is seen to present a base line which shows the position of the string when no current passes, that is, when the potential of its two ends is the same, and starting from the base line are five waves lettered P, Q, R, S, and T. The best understood and most important of these are those which rise above the base line, that is, which are positive, P, R, and T. The term positive here has reference only to the direction of the curve with reference to the base line. Each of these positive waves means that the base of the heart is electrically negative to the apex, or, to be more exact, that the algebraic sum of all the differences of potential that exist in the heart at that instant results in negativity of the upper end of the string toward the lower end to an extent indicated by the amplitude of the wave. On referring to Waller's diagram, Fig. 3, it is readily understood why it is that not only the height of a wave but also its direction may be modified by varying the position

Digitized by Google

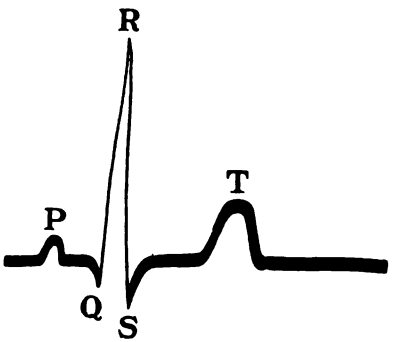


FIG. 7.—Scheme of the normal electrocardiogram.

Digitized by Google

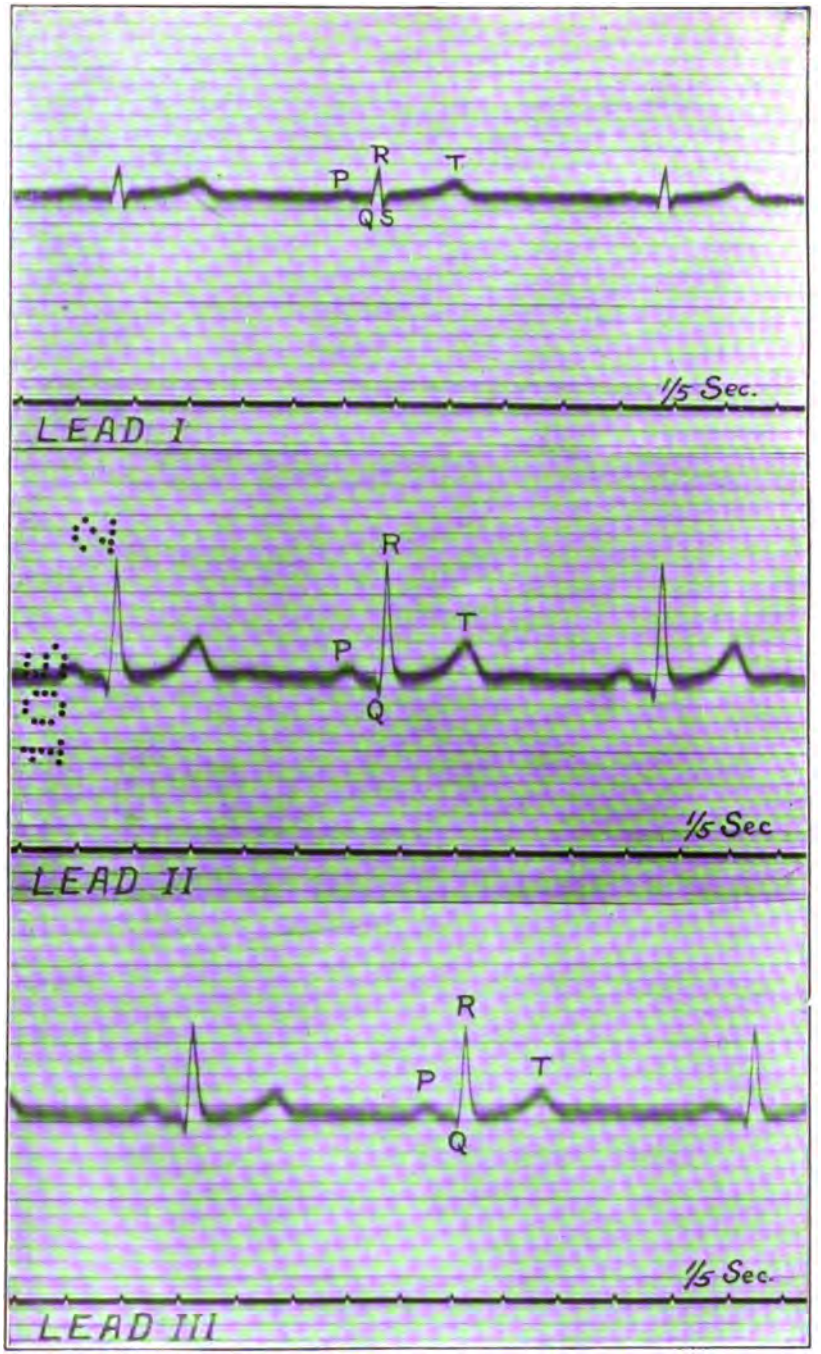


Fig. 8.—Electrocardiogram of a healthy adult male, taken while sleeping.

Digitized by Google

of the electrodes upon the body. P corresponds to the contraction of the auricle. The causal relation between auricular systole and P has been positively established by study of the exposed heart in animals, as well as by the observation of cases of auriculoventricular dissociation in human beings. Q, R, S, and T all correspond to the systole of the two ventricles. R and T are the most constant of these, and as far as our present understanding goes, are the most important and useful in electrocardiography. R and T are always present in health, while Q and S may, either one or both, be absent.

Observers are not in entire agreement as to the significance of the waves that make up the ventricular portion of the curve, but the following is a summary of the leading views:

The space between P and Q indicates the time elapsing between excitation of the auricles and ventricles, and is, therefore, the best measure we have of the auriculoventricular interval.

Q directed downward, and therefore indicating negativity of the apex toward the base, has been supposed by Einthoven[23] to be due to an initial contraction of apical fibers, and the variations in this wave in individual cases to be due to variations in the distribution of the fibers of the bundle of His. Q in health is always small and is often absent. It passes at once into R, the highest, most uniform and useful of all the waves.

R corresponds to the initial contraction of the ventricles at the base, and indicates marked negativity of the base of the heart. It is possible that it is produced by the initial contraction of the papillary muscle system. As has been shown by Hering,[25] the papillary muscle system contracts before the apical muscle mass, a physiological fact which seems to bear out the latter view and is in agreement with the anatomical findings of Tawara,[24] that the earliest and most extensive dis-

Digitized by Google

tribution of the fibers of the bundle of His is to the papillary muscles.

We may be reasonably sure that the wave R continues to rise while the contraction wave of the ventricle is spreading from base to apex, and the summit of R marks the instant at which this contraction has reached the apex of the heart; the time during which this wave R is rising is then a measure of the time occupied by the ventricular systole in spreading from base to apex, and may well be a matter of value in the study of diseases of the heart muscle, for knowing the distance, it is possible to calculate the rate of travel, as has been done by Gotch[28] in the exposed heart of the tortoise. During the interval between R and T the string remains at zero. This does not indicate a cessation of muscular activity, but only that all parts of the muscle are equally active and therefore the potential of base and apex remain the same. It is probable that this time period also will be of value in the study of the diseased heart.

R is frequently followed immediately by a negative wave S, the significance of which is still in doubt.

T, the final wave of the ventricular phase of the electrocardiogram, is usually directed upward, and therefore indicates relative negativity of the base to the apex, that is, a preponderance of basal over apical activity at this instant, which is the very end of a ventricular systole; this might mean either that the base remained in contraction after the apex had begun to relax, or that a second contraction occurred at the base at this time. If the latter is the case, T might be produced either by fibers that had already been in activity during R, or by fibers that had not previously been brought into play. On account of the law of the refractory phase, the former hypothesis seems unlikely, and recent studies by Gotch[28] show fairly conclusively that the latter supposition is the true explanation.

Digitized by Google

Gotch, with his delicate capillary electrometer, has investigated the electrical condition of various portions of the heart's surface in animals throughout the cardiac cycle. This work has thrown so much light upon what had been one of the most puzzling features of the normal electrocardiogram that it seems wise to describe his conclusions in some detail. Using flexible electrodes of special construction, Gotch found that when the current was led off from the base of the ventricles at a point as far distant as possible from the spring of the aorta, the other electrode being applied to the apex, the electrocardiogram presented the form of a diphasic variation. When, however, the basal electrode was applied at the root of the aorta, the other being still at the apex, a curve was obtained with a final upward-directed wave similar to the T wave of the normal electrocardiogram, indicating that at this terminal instant the region at the root of the aorta was negative to the apex, that it was in a state of greater activity than the apex. Gotch then proved that this activity in the region of the aorta was due to the contraction of fibers which did not take part in the original basal contraction. This he accomplished by applying electrodes to the base of the ventricles at a distance from each other, one close by the root of the aorta. This arrangement of electrodes gave a curve which was a simple diphasic variation, indicating that the first mentioned point became first active, then inactive, the second point vice versa.

To quote from Gotch's conclusions: "The interpretation of the triphasic records is shown to be in accordance with the view that each contraction begins in the general mass of base ventricular substance, that it then develops at the apex, and that it finally develops in the ventricular mass near the aorta (or pulmonary artery), with a possible extension into the wall of the aorta or pulmonary artery." His reasonable inference

Digitized by Google

from these facts is that the wave of excitation in the heart follows the route of the original primitive cardiac tube of the lower animals and the embryo, the bending of which upon itself in the course of development gives rise to the complicated heart of the adult mammal. Thus, this mode of propagation is the remains of an original peristalsis, and probably in the finished heart is necessary to the completest possible emptying of the organ in the shortest possible time and with the least possible labor, and T expresses the homologue of the final contraction of the bulbus arteriosus in the lower animals.

It is customary to designate the lead by which any wave has been obtained by attaching the corresponding Roman numeral to the wave letter, for instance, P III, meaning P in lead III. As a rule, in health all the waves are best marked in lead II, especially R. In many persons all the excursions in lead III are very small, and T III may be negative in some normal subjects. Negative P and R waves in any lead are an indication of abnormality. It is an interesting fact, and one which necessarily follows from the mode of leading off the current from the surface of the body, that the height of any wave in lead III can be obtained by subtracting the value of the same wave in lead I from that in lead II, or, as Einthoven[11] puts it, lead II minus lead I equals lead III.

The electrocardiograms of a number of healthy individuals show differences, but the curve in each case will be peculiar to that person and will be constant, so that persons may be identified by their electrocardiograms, as was noted by Einthoven. These variations, however, are within the normal range of health.

Many normal electrocardiograms show physiological variations. For instance, the height of R varies with respiration, being lower during deep inspiration. T is increased by any

Digitized by Google

agency which increases the force of ventricular systole, as exertion or increased blood pressure. Increased pulse frequency causes a shortening of the diastolic interval with an approximation of T to the following P, which may reach a point where P and T occur together.

There are certain features of the normal heart beat which can be studied better by this method than by any other. For instance, it is possible to study the time of propagation of the wave of excitation through either the auricle or the ventricle. Moreover, the interval between the auricular and the ventricular phase of the electrocardiogram gives a very accurate index of the time of propagation of an impulse through the bundle of His. Inasmuch as the form of the electrocardiogram depends upon the point of origin and direction of propagation of the wave of excitation, any variation in such origin and direction will be indicated by corresponding changes in the form of the curve. Thus, it becomes evident that this method is of great value not only in the investigation of morbid conditions, but also in the study of normal physiology.

II. THE ELECTROCARDIOGRAM IN SOME FAMILIAR DISEASES OF THE HEART.

In the first section of this communication we have seen that the electrocardiogram in health is a curve whose general character, though subject to individual variations, is much the same in all normal persons. As might be expected, this curve is subject to very marked alteration in various diseases of the heart, and for the practical physician it becomes a matter of great interest to know what information, expressed in terms of anatomical change or alteration of function, can be derived from the study of the pathological electrocardiogram.

Digitized by Google

In considering the factors which bring about change in the form of the electrical curve, it must be constantly borne in mind that this curve is purely the expression of changes in the electrical condition of the heart, due to muscular activity. Movements of the blood or mechanical disturbances of valves have no direct effect on this record.

It has been previously shown that the character of the curve varies with the points of the body surface from which the current is led off. A theoretical consideration of the physical laws which determine the spread of potential would carry us too far afield. It may be stated as an observed fact that variations in the position of the heart within the chest will also cause marked changes in the form of the electrocardiogram.[28] Similarly, marked changes in the shape of the muscle mass affect the curve. Still more striking variations are those caused by contractions which originate in abnormal situations and pursue an abnormal course through the muscle.

We shall present records of some of the more common of these conditions with such comment on their interpretation and significance as seems desirable from the standpoint of the practitioner of medicine.

HYPERTROPHY. Our knowledge of this subject is at present largely empirical, and analysis of the exact conditions which bring about the observed changes is beset with very considerable difficulties. Further study may eventually permit such an analysis, but for the present we shall confine ourselves to a description of the form of the curves with which we find hypertrophies associated.

As has been previously shown,[29] in leading the current from any pair of the three extremities customarily chosen, the three principal peaks, P, R, and T, are usually directed upward in normal subjects. The tall peak R is of especial interest in

Digitized by Google

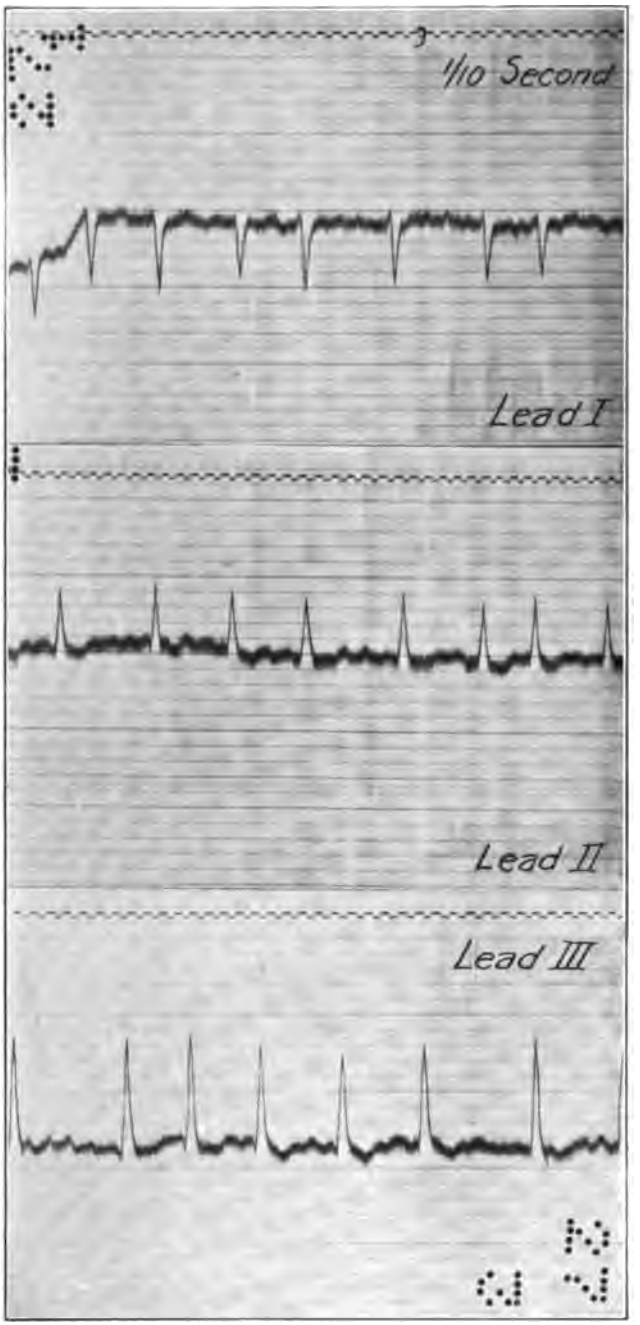


FIG. 9.—Reversal of R. 1. in hypertrophy of the right ventricle. The heart is completely irregular and waves of auricular fibrillations appear. (See Fig. 17.)

Digitized by Google

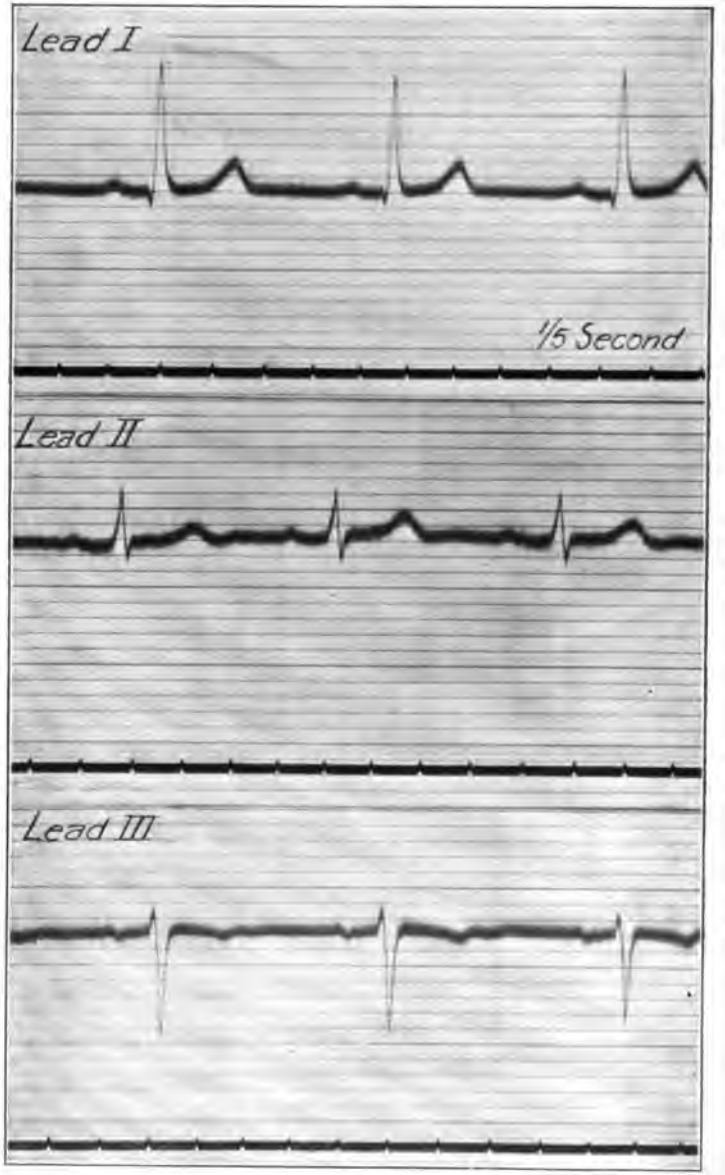


FIG. 10.—Hypertrophy of the left ventricle in mitral insufficiency.

Digitized by Google

hypertrophy, and we shall refer to R in lead I as R I, in lead II as R II, etc. Normally all three are directed upward, and of the three, R II is usually of greatest height, R III of least. It has been shown by Einthoven," and confirmed by others, that in hypertrophy of the right ventricle, R I is very small in extent upward, or may be directed downward, usually the latter in well-marked cases; at the same time R III is directed upward, and is relatively of greater magnitude than in normal subjects (Fig. 9). In hypertrophy of the left ventricle the opposite condition obtains, R I being directed upward, and often of enormous height, while R III is directed downward, frequently to the extent of 2 cm. (or 2 millivolts)[1] (Fig. 10).

As before mentioned the theoretical explanation of these facts is difficult, and in the absence of more definite knowledge, extensive speculation would be unprofitable. The empirically determined facts that a downward directed R I with upward directed R III signifies right ventricular hypertrophy, and that an upward directed R I with downward directed R III means left hypertrophy, are of the greatest clinical significance. While in most cases the ordinary methods of physical examination suffice for a diagnosis of left hypertrophy, the determination of right hypertrophy is not infrequently a matter of much uncertainty, and with thick chest walls, emphysematous lungs, or in the presence of fluid, consolidation, or new growths, the difficulty may be unsurmountable.

So far as we know at present, the only conditions, aside from hypertrophy, which can produce a similar electrocardiogram, are changes in position of the heart in the chest and lesions of one limb of the auriculoventricular bundle. It has been found by us that to produce, by change in position of the normal heart, changes comparable to those caused by hypertrophy, requires a very considerable displacement of the organ. As this

Digitized by Google

will form the subject of a subsequent communication, it will not be dealt with in detail here. Such anomalies of position, however, are of comparatively infrequent occurrence as congenital phenomena, and, as a rule, pathological conditions which could cause marked alteration in the position of the heart present little difficulty in diagnosis. We shall have occasion to consider lesions of one limb of the bundle of His a little later.

Concerning hypertrophy of the auricle, our knowledge is less definite. It may be assumed to exist in the left auricle in cases of well-marked mitral stenosis with good compensation, and in some of these cases a decided increase in the magnitude of the wave P has been noted.

In the discussion of hypertrophy we have followed Einthoven's nomenclature, referring to the principal sharp peak as "R," whether directed up or down. Some writers have recently referred to the downward directed wave as "S," but in the absence of exact knowledge of the underlying causes of the change, we feel that the confusion resulting from change in nomenclature is not balanced by any well-defined advantage.

DISTURBANCES OF RHYTHM. Irregularity in the cardiac rhythm has long been familiar as an accompaniment of cardiac disease, and during recent years the study of simultaneous arterial and venous sphygmograms has clearly shown that irregularity may arise in several different ways. Though some of these types of irregularity permit of immediate and easy diagnosis from the sphygmograms, and nearly all of them can be distinguished by close study, their essentially different characters are especially well marked in the electrocardiograms.

Cardiac irregularity may arise as the result of variations in the intensity of vagus innervation. As MacKenzie[21] has pointed out, this irregularity most frequently takes the form of an occasional slowing of the pulse, often occurring at the time of

Digitized by Google

Digitized by Google

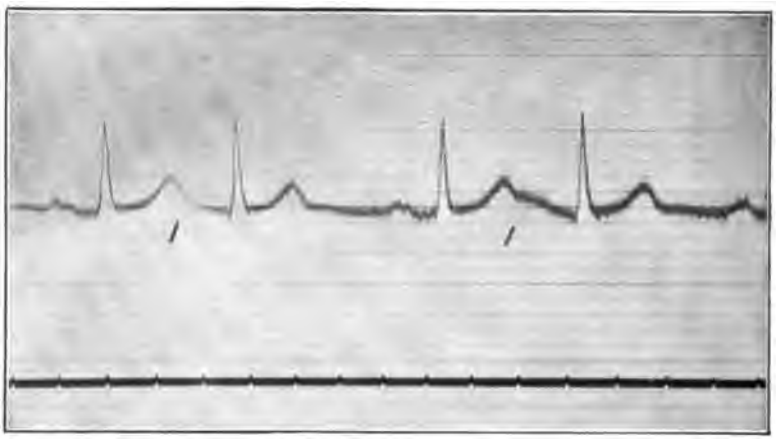


FIG. 11.—Irregularity due to premature auricular (sinus?) contractions.

Digitized by Google

inspiration, as though it were a reflex increase in vagal innervation. In such cases the electrocardiogram shows only a lengthening of the diastolic interval, the interval between T and P, without other change.

Irregular acceleration of the auricular rhythm has usually been ascribed to the occurrence of auricular extrasystoles. MacKenzie takes this view, and from his definition of an extrasystole as taking origin in some part of the heart other than the sinus region, we presume that he considers the site of origin of these accelerated auricular beats to be always some part of the auricle other than the place of origin of the regnlar rhythm. While this is unquestionably true in some cases of irregular auricular acceleration, we can see no reason for the assumption that the sinus region itself may not in some cases initiate a premature beat. It is well known that vagal control affects principally the auricles, and if an occasional increase in the strength of vagus tone will cause a delayed beat, it seems reasonable to suppose that the reverse may be true.

Fig. 11 is the electrocardiogram of a patient who has occasional premature beats of auricular origin. Such a premature beat is shown at 1. It will be seen that the P or auricular wave of the electrocardiogram, follows so closely on T of the preceding ventricular phase as partially to merge with it. The ventricular phase corresponding to this premature P is entirely similar in form to those of the normal rhythm. There is a slight lengthening of the succeeding diastole, but certainly not enough to entitle it to be considered a compensatory pause in the usual acceptation of that term. Furthermore, the radial pulse at the time of these premature beats is as strong and full as at any other time.

This patient presents the clinical evidence of aortic regurgitation, with some mitral stenosis. Compensation is good and

Digitized by Google

there is little evidence of hypertrophy, a clinical finding which is confirmed by the absence of reversal of R III in the electrocardiogram. He has had occasional attacks of tachycardia, usually induced by the swallowing of very cold liquids. The record was taken during a period of comfort, with normal pulse rate. The fact that there is but slight hypertrophy, and the character of the irregularity, seem to indicate that the integrity of the heart muscle is fairly well preserved. It is possible that the attacks of tachycardia in his case may have their origin rather in disturbance of the inhibitory or accelerator nervous mechanisms than in an altered condition of the auricle itself.

Fig. 12 is from a young man, aged nineteen years, in whom cardiac irregularity was discovered during a routine examination at his college gymnasium. At (1) it will be seen that a premature beat occurred. Its auricular origin is evidenced by the alteration in form of the preceding T, which is seen to be increased in height, and bifid. The succeeding ventricular cycle presents a little variation from the normal form. It will be noticed that there is an increase of some 4 mm. in the height of R, while T is markedly diminished in height—about 2 mm., as compared with the normal 4 mm.

In this instance an impulse starting in the auricle produces an anomalous contraction of the ventricle. This is difficult to understand in the light of our present conception of the physiology of the auriculoventricular bundle. We have been wont to presume that all impulses reaching the ventricle by way of the bundle would produce therein the same effect, no matter what their origin in the auricle. Evidence is accumulating which tends to indicate that the relations of the bundle to the auricle are less simple than anatomical studies would lead us to presume.

Digitized by Google

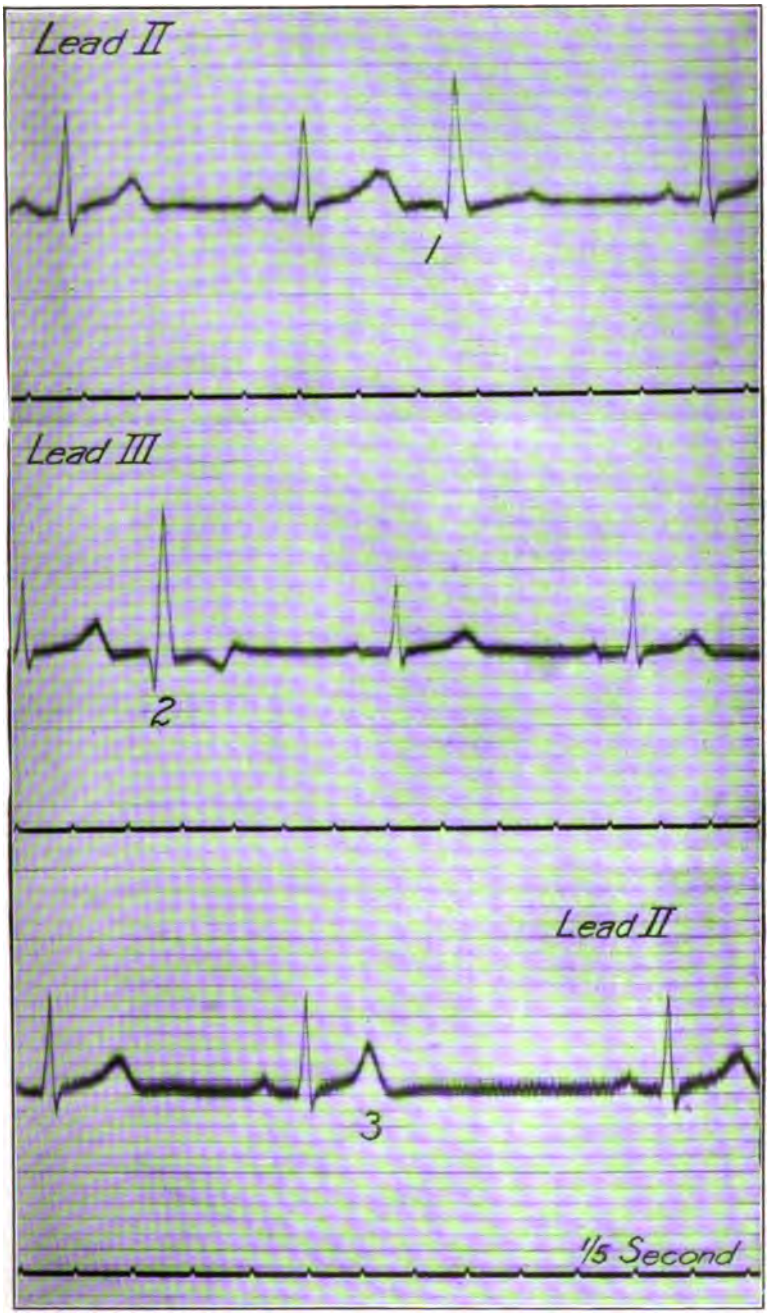


FIG. 12.—Auricular extrasystoles at 1, 2, and 3. The auricular extrasystole at 3 fails to provoke a ventricular response.

Digitized by Google

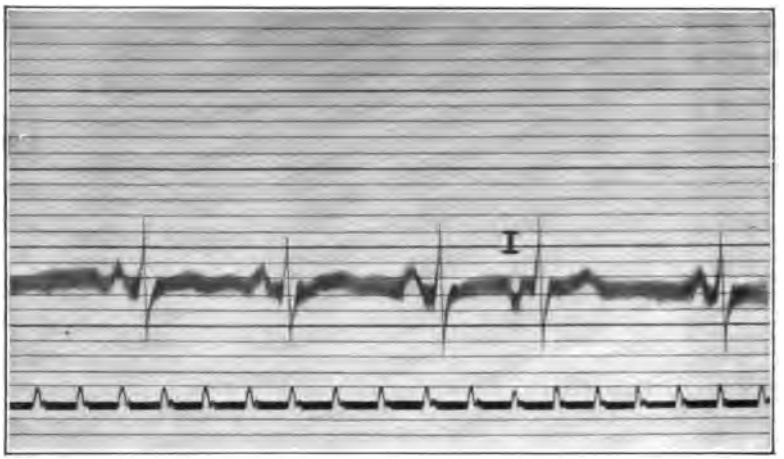


FIG. 13.—Auricular extrasystole (*I*). The reversal of the P-wave indicates that the contraction wave travels in the reverse direction.

Digitized by Google

Lewis[2] has called attention to the fact that the form of the ventricular electrocardiogram evoked by an auricular extrasystole may differ from the form evoked by the normal auricular activity, and further, that in the same subject auricular extrasystoles may evoke more than one anomalous type of ventricular activity. Quite possibly, further study will show that the bundle consists of fiber strands which converge from different parts of the auricle.

At (2), Fig 12, another auricular extrasystole is shown, followed by a ventricular phase, which departs even more from the normal. At (3) is figured the electrocardiogram of another premature beat. Here the premature beat is indicated only by alterations of the preceding T, and a long pause following. The preceding T is increased fully a millimeter in height, and is not bifid, its top presenting a peculiarly sharp point. Here the premature contraction has occurred so early as to fuse its electrical activity completely with the final phase of the preceding ventricular cycle, and so early as to find the ventricle still in the refractory phase; or, what is much the same, that the conducting paths were refractory as a result of the immediately preceding cycle. The fact that the deformation of the T wave is of the nature of a reinforcement shows that the electrical disturbance caused by the premature auricular contraction was of the same general character as that attending normal beats. In other words, the muscle contraction passed from base toward apex in the auricle.

In Fig. 13 the premature contraction at (1) is distinguished from the normal beats, aside from its prematurity, by the fact that the auricular phase of the electrocardiogram is in the reverse direction from the normal. All the P waves of the regular rhythm are seen to be directed upward, indicating passage of the contraction wave from base toward apex in the auricle.

Digitized by Google

In all the premature beats in this case the P wave is reversed, indicating an origin of the premature beat at a point nearer the ventricles than the site of the normal rhythm.

In this instance there can be no doubt as to the ectopic origin of the early beat, and it is especially interesting to find that in the ventricular response there is a marked departure from the type evoked by auricular impulses of the normal rhythm. It is plainly to be seen that the wave T is of very small magnitude throughout the normal rhythm, but that the ventricular response to each ectopic auricular beat presents a T wave of much greater height.

Extrasystoles Originating in the Ventricles. Ectopic beats originating in the ventricles give rise to electrical phenomena of various types, according to their place of origin. From anatomical considerations we should expect ectopic beats originating in the auriculoventricular bundle above its division into right and left limbs, to give an electrocardiogram not very different from the ventricular portion of the normal electrocardiogram in the same individual. Since the contraction wave must spread through the ventricular masses in the same manner as a normal contraction wave, it seems reasonable to suppose that the resulting systole will be in every way similar to the normal ventricular systole and attended with a similar electrical complex. In cases of complete heart block, in which the ventricle assumes an independent rhythm, it is found that the ventricular electrocardiogram is of about the same form as the ventricular phase of a normal curve. Records of two such cases have been published by Einthoven.[28]

The tissue of the bundle below the block seems to be the most irritable part of the ventricle, and therefore determines the point of origin of the contraction.

Digitized by Google

Digitized by Google

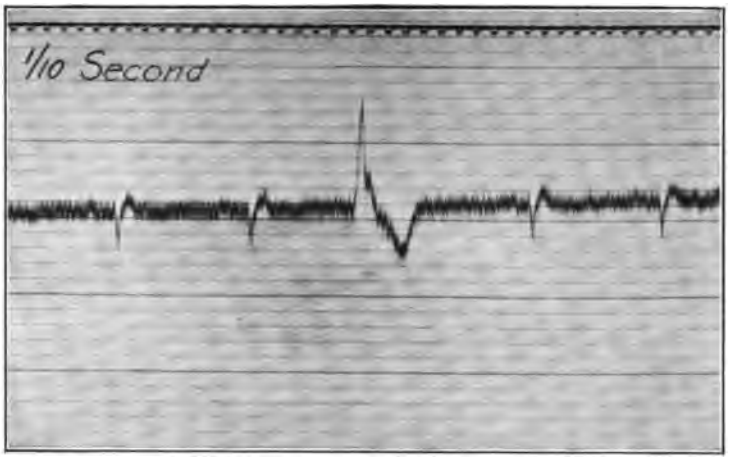


FIG. 14.—Ventricular extrasystole.

Digitized by Google

The greater number of ventricular extrasystoles, however, gives rise to an electrical complex entirely different from anything found in the normal electrocardiogram. Einthoven[34] has referred to these contractions as "atypical contractions." The most striking features of these atypical electrocardiograms are the abnormally large magnitude of the differences of potential and their close resemblance to the diphasic variation which results when a single muscle wave traverses a piece of skeletal muscle. The form of the atypical curve varies with the lead chosen and with the site of origin of the beat, as may easily be proved by animal experimentation. It is a fairly uniform characteristic of the atypical contractions that the magnitude of the recorded electromotive forces is greater than is the case with normal contractions in the same individual (Fig. 14).

In attempting to understand these facts we shall find it helpful to consider the factors which contribute to the formation of the normal electrocardiogram. The anatomical distribution of the bundle suggests, as pointed out by Einthoven,[35] that the ventricular systole is not simply a contraction wave passing from base to apex, but that the impulse normally reaches many parts of the ventricle at once. We may almost think of the bundle as a sort of primitive motor nervous system connecting auricles with ventricles. The normal ventricular contraction is a coördinated, more or less complicated action. The arrangement of the ventricular muscle fibers is complex, and if we conceive that the normal mechanism of contraction consists in the simultaneous activity of a large part of this musculature, it becomes evident that in different parts of the ventricle muscle waves will be traveling at the same instant, some in one direction, others in another. The electromotive forces resulting from the activity of muscle fibers, in which the direction of propagation of the wave is the same, will be added,

Digitized by Google

while the electrical effect of muscle waves passing in an opposite direction will be subtracted. The total effect at any instant will be the algebraic sum[28] of all the electromotive forces. The maximum electromotive force measured is not necessarily a criterion of the maximum muscular activity. It might conceivably happen that at the time of maximum muscular activity the electromotive forces would nearly balance each other.

To restate the matter briefly, the form of the ventricular electrocardiogram appears to be the expression of the algebraically summed electrical effect of several contraction waves passing simultaneously in various directions through the musculature.

So long as the ventricular systole is initiated through the intermediary action of the bundle, the contraction complex will be constant—except as noted above in the cases of certain auricular extrasystoles.

In the light of these considerations, such a curve as Fig. 14, which is the electrical expression of a ventricular extrasystole, becomes comprehensible. We see that the magnitude of the electromotive forces is much greater than the magnitude of the maximum electromotive force of the normal beats; also, that the curve is a diphasic variation, but with unequal phases. The point of origin of the contraction cannot, in the present state of our knowledge, be stated definitely. It is an experimental fact,[29] that extrasystoles evoked by either mechanical or electrical stimulation of points on the surface of the ventricles are attended with an electrical complex similar in its main features to the one figured. The direction of the first phase and the details of the form vary with the exact location of the point stimulated, and with the leads.

We may consider it established with a fair degree of probability that such contractions start either in the muscular mass

Digitized by Google

of the ventricles themselves, or in some of the terminal branches of the bundle tissue. Those who lean to the theory that the initiation of a contraction is a peculiar function of the remains of the primitive cardiac tube will prefer the latter view, though there seems to be no valid reason to exclude the possibility of the initiation of a contraction by any part of the muscle.

At all events, it is evident that the path of propagation of such a contraction wave through the ventricles cannot possibly approximate the normal. From the form of the electrocardiogram it appears that the contraction wave travels over the muscle mass in much the same way as contraction waves pass over portions of skeletal muscle. Instead of a complex coördinated activity of numerous parts of the ventricle simultaneously, we have here a spread of the wave from point to point by contiguity. This view is further supported by the increased magnitude of the electromotive forces, indicative of the fact that there is less neutralization of the electrical effect by simultaneous waves passing in the opposite direction. The fact that the two limbs of the diphasic variation are unequal is doubtless to be referred to the fact that while we are here dealing with a comparatively simple contraction wave spreading from a single point, it is spreading through a complex muscle with the result that the changes in potential of the whole surface of the heart are not quite symmetrical during the early and later stages of the systole.

The well-known fact that an extrasystole of the ventricle is usually almost ineffective in propelling blood has been generally ascribed to the fact that it occurs soon after a normal systole, at a time when the heart is presumed to be nearly empty.

The volume curve of the ventricles, obtained with one of the various forms of cardiometer,* shows that ventricular filling begins so soon after the completion of systole as to produce a

Digitized by Google

smooth curve without break, and that the filling occupies about the same length of time as the emptying. Throughout more than half the diastolic period with normal pulse frequency the ventricles are full, except for the insignificant amount which the auricular systole will add. At the time of occurrence of the extrasystoles there must be a very considerable amount of blood in the ventricular cavities.

We desire to suggest the view that the ineffectiveness of such systoles is due not so much to lack of blood to be propelled, or of energy to propel it, as to the fact that the energy is misdirected; the fact, clearly shown by the electrocardiogram, that we are dealing with an incoördinate contraction, a temporary ventricular ataxia. This suggests an explanation of the magnitude of the enormous jugular regurgitant wave which sometimes accompanies extrasystoles in cases of tricuspid insufficiency. Such a case has been described by one of the writers.*

It is characteristic of ventricular extrasystoles that they are followed by a compensatory pause of such length that the total duration of the last preceding normal cycle and the extra beat with the succeeding pause is very nearly equal to the time of two normal cycles. This is a consequence of the dependence of the normal rhythm of the ventricles on the auricular rate. The auricular beat following an extrasystole finds the ventricle refractory. The next auricular beat occurs after the usual interval, and the ventricle remains quiescent until it receives another stimulus from the auricle. The nearer the extrasystole occurs to the time of a normal beat, the shorter will be the compensatory pause. If an extrasystole of the ventricle were to occur at the same time as the auricular contraction, the pause following would be longer than a normal diastole by about the length of time which normally elapses between the auricular and the ventricular systole—that is, about one-tenth of a second.

Digitized by Google

Digitized by Google

FIG. 15.—Pulsus bigeminus.

Digitized by Google

Fig. 15 is from a patient with bigeminal pulse, each alternate beat being a ventricular extrasystole until the last beats the record, where the normal rhythm was resumed. It will be observed that the first two and fifth extrasystoles have been attended with unusually large differences of potential. From the normal beats at the end of the record it may be seen that the auricular rhythm is not quite regular. If one measures the time between the middle two of these auricular systoles it will be found to coincide exactly with the time which elapsed between each of the very prominent extrasystoles and the last preceding auricular systole.

The electrocardiogram of the fourth extrasystole shown in Fig. 15 presents a small, upward-directed wave interpolated between the two phases of the diphasic curve. The time interval between the last preceding P wave and this small notch is almost exactly the same as that between the first and second P waves of the normal beats at the end of the record. In the case of the extrasystoles which present the extremely large electromotive forces, the thought suggests itself that the auricle has been in contraction at the same time and summed its effect with that of the ventricle.

In the case of the interpolated notch, in the fourth extrasystole, there seems to be considerable reason for presuming that it was caused by auricular activity.

Whether the height of the three large curves was increased by auricular activity occurring at the time of the ventricular contraction seems less clear. The normal P waves have a height of but 2 or 3 mm., while the first curve of the diphasic variation is from 4 to 6 mm. higher than the first curve of the smaller ones. The second, or downward-directed phase of the three large curves, extends 6 mm. below the zero line, while that of the smaller curves extends but 2 or 3 mm. below. This might

Digitized by Google

be accounted for by partial neutralization by simultaneously occurring P waves. The fact that the pauses following the large atypical curves is of about the same duration as that following the smaller ones seems to speak against the supposition that the large curves are due to summation, as does also the fact that the time intervening between the preceding normal beat and the extrasystole is very nearly the same in all cases. Possibly the difference in character of the electrocardiograms of the extrasystoles is merely an expression of the fact that they have arisen from different parts of the ventricle.

THE COMPLETELY IRREGULAR HEART. During the last few years interest in the study of anomalous varieties of heart action has centered on a form of irregularity now familiar to every clinician as a distinct type. This type of arrhythmia has been described under several names, corresponding to a number of theories which have been advanced as to its origin.

Following MacKenzie's hypothesis, the term "nodal rhythm" has been largely applied to it in this country and in England. In Germany, following Hering, it has been designated the pulsus irregularis perpetuus, though it has been established that cases occasionally occur in which the arrhythmia is not "perpetual." Other names for the same condition are "completely irregular" and "absolutely irregular" pulse.

The literature of the subject has attained formidable proportions, and only that portion of it will be referred to which is particularly relevant to the present discussion.

The leading characteristic of this complete irregularity, as determined from tracings of the arterial and venous pulses, is the absence from the venous curve of any evidence of auricular contraction, the waves of the venous pulse occurring in synchronism with the ventricular systole.

Digitized by Google

MacKenzie[30] originally advanced the view that these cases are the result of auricular paralysis, and considered that, in the absence of auricular contraction, the rhythm is set by the ventricles. Subsequently, the finding at autopsy in some of his cases that the auricles were the seat of hypertrophy led him to modify his views and assume a simultaneous contraction of the auricles and ventricles. To account for such a simultaneous contraction he assumed as the site of origin of the rhythm the tissue situate in the region between auricles and ventricles, and eventually assumed the node of Tawara[31] as the most probable site of origin of a stimulus which he conceived as passing upward to the auricle and downward to the ventricle.

Hewlett[32] and Hering[33] have both called attention to the difficulty of reconciling MacKenzie's view of an infra-auricular origin of the rhythm with the well-known fact that when, in cases of complete heart block, an independent ventricular rhythm is known to exist, this rhythm is not only regular, but very much slower than the rate usually observed in complete irregularity. In the article above referred to, Hering recognizes that the weight of evidence is in favor of a supraventricular origin of the rhythm. He concludes that the particular supraventricular portion of the heart in which the stimulation arises is as impossible to determine as is the cause of the irregularity itself. In a further communication, Hering[34] notes the absence of the auricular (P) wave in the electrocardiogram of complete irregularity. Having convinced himself by animal experimentation that contractions of the auricle, so feeble as to be all but indistinguishable by mechanical means, give, nevertheless, a distinct auricular electrocardiogram, and also that the auricular wave is still to be distinguished from the initial wave of the ventricular electrocardiogram when the two chambers have contracted within one-fiftieth of a second of each other, he

Digitized by Google

is led to the conclusion that in complete irregularity the auricular contraction occurs at exactly the same instant as the ventricular, or else that it fails altogether. In a still more recent paper[*] he commits himself to the view that the theory of complete standstill of the auricle is the one best supported by the evidence. In brief, he refers the origin of the stimulus either to the regions of the mouths of the great veins or the muscle of the auricle, but supposes that the production or transmission of the wave of excitation by the auricle is unattended by contraction of that chamber.

This is a most novel and ingenious conception. That in a condition of depression of the function of contractility the function of conduction or of stimulus production may still be preserved seems theoretically possible. That conduction of a stimulus can take place without giving evidence of an attendant action current in a galvanometer adjusted to the sensitiveness suitable for the recording of the electrocardiogram is evident from the fact that in the normal electrocardiogram the string remains at rest during the time of passage of the excitation wave through the auricoloventricular bundle. In our estimation, however, the weak point in this theory is its failure to account for the irregularity which is really the crux of the situation. That any single region of the cardiac muscle can develop an irregular rhythm seems very unlikely in the light of our knowledge of the physiology of cardiac muscle. The excised and perfused mammalian heart beats with a perfectly regular rhythm; strips cut from the cold-blooded heart beat regularly, and strips of mammalian heart muscle can be made to contract rhythmically, but always with a regular rhythm. Even skeletal muscle placed in a suitable solution of salts can be made to execute rhythmic contractions, and these are regular.

Digitized by Google

By exclusion we are forced to seek an explanation along other lines than those thus far indicated.

In January, 1907, Cushny and Edmunds[28] reported a case of paroxysmal irregularity of the heart, which inspection of the arterial pulse tracings shows to have been of the completely irregular type during the paroxysms. Having previously observed a very irregular action of the ventricles in animals in which auricular fibrillation occurred during the course of operative procedures, they were led to make a comparative study of the pulse in the two conditions, and offer the suggestion that the condition of their patient may have been due to paroxysms of auricular fibrillation.

Within the last year, Rothberger and Winterberg[29] have published electrocardiograms obtained from animals during auricular fibrillation experimentally produced. Their electrical records exhibit, in addition to the characteristic irregularity of the rhythm, a peculiar undulatory movement of the string shadow during the diastolic intervals. There is no trace of the normal auricular action current (P). Their electrocardiograms, taken from clinical cases of "Pulsus irregularis perpetuus," present in all respects a most striking resemblance to the experimental curves.

Lewis,[30] of London, has published similar experimental and clinical records, and in his clinical cases, by the use of special electrodes applied directly to the chest wall, he has succeeded in obtaining an especially clear record of the diastolic undulations. As long ago as 1906, Einthoven[31] published electrocardiograms from two cases of this type of irregularity, both of which records exhibit the characteristic diastolic undulations and absence of P-waves.

Hering's electrocardiograms also exhibit the undulations, though they are rendered more or less obscure by the super-

Digitized by Google

position of oscillations of a more rapid period, probably due, as he suggests, to tension of skeletal muscles.

The diastolic undulations which replace the P wave in complete irregularity are irregular in rate, but decidedly slow as compared with the action currents of voluntary muscle. The latter, as has been shown by Piper,[46] occur at a rate of from 47 to 50 per second, while in our records the undulations of complete irregularity have a frequency of from 7 to 15 per second, so that they can frequently be observed directly during the taking of the record. On account of the proximity of the hospital to electric car lines, we have been unable to eliminate mechanical vibration entirely from our records; but by taking control curves with every record we have convinced ourselves that the period of vibration of the building is always shorter than that of the undulations in question and longer than that of the voluntary muscle action currents. During the last six months we have taken upward of 300 records, and among all these records nothing corresponding to the undulations of complete irregularity has been found in any case from which the irregularity was absent.

Lewis has called attention to the fact that the height of the undulations is often as great as that of a normal P wave. Hering[47] reports that he has observed very large differences of potential to result from ventricular fibrillation. Kraus and Nicolai[48] have published the electrocardiogram of a dog in agonal ventricular fibrillation.

Fig. 16 is the electrocardiogram of a dog taken during ventricular fibrillation. The maximum excursions are of greater height than were the R waves of the normal electrocardiogram in this animal. The magnitude of the electromotive forces is doubtless to be explained in the same manner as was suggested in the discussion of ventricular extrasystoles.

Digitized by Google

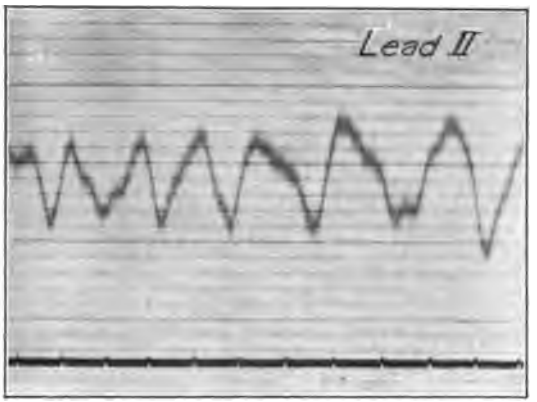


FIG. 16.—Action current of ventricular fibrillation in a dog's heart.

Digitized by Google

Digitized by Google

Rotheberger and Winterberg have indicated their belief that the completely irregular pulse is the result of auricular fibrillation. Lewis has definitely stated his belief that such is the case.

The most important arguments in favor of this explanation may be summarized as follows: It accounts for the rapidity of the rhythm by assigning its origin to the auricles. It accounts for the irregularity. Impulses originate from many points in the auricular musculature, and there may be as many rhythms as there are points of origin. Not every impulse will affect the ventricle, but the chance of its securing a regular rhythm from its delirious pacemaker is very slight. Finally, the correspondence between the clinical condition and the experimental seems to be complete in every feature.

In the article cited, Hering[46] states that while the hypothesis of fibrillation explains the facts in complete irregularity better, he considers his assumption of auricular standstill to be better supported. The objections which he raises have been answered seriatim by Rothberger and Winterberg,[44] and we must refer to the original articles for the discussion.

Upon one objection we wish to comment. Hering[46] makes the statement that to have the diagnosis of fibrillation in complete irregularity accepted, it must first be proved that the auricles can go on fibrillating for weeks and months, and even for years, as complete irregularity is known to do. He cites Hewlett as having raised the same objection. To this we reply that no evidence is at hand to indicate that fibrillation of the auricles may not persist indefinitely. Once established in the ventricles, fibrillation tends to persist until death, which must shortly ensue through failure of the circulation. Auricular fibrillation is far from crippling the circulation. Blood pressure remains good, and animals may be kept alive for hours

Digitized by Google

with auricles fibrillating. When auricular fibrillation is produced experimentally there is at first a tendency for the auricle to resume the normal rhythm on cessation of the faradic stimulation used to provoke delirium. The oftener the auricle is thrown into fibrillation the longer does the condition persist after cessation of stimulation; at least, that has been our experience. We do not know as yet what underlying factors induce the clinical condition which we believe to be auricular fibrillation, but it seems probable that it will be found to be a degenerative process involving the auricular musculature. At all events, if it be found to be a permanent organic change, there is every reason to suppose that it will tend to perpetuate the condition it has produced. The occasional reversions to the normal rhythm in cases in which the incidence of the complete irregularity has been recent, and the tendency which Hering has noted for this rhythm to become eventually permanent, seem to furnish an additional argument in favor of the fibrillation hypothesis.

Since we have been able to apply the galvanometer to the study of these cases, we have had opportunity to secure records from 16 patients who presented the completely irregular type of pulse. Fig. 17 illustrates typical curves from such cases. It will be seen that there is some variation in the heights of the peaks R and T, and it can be determined that this variation is not conditioned on the respiratory rhythm.

In some cases there is deformation of T, and in some this wave is difficult to distinguish. These characters are to be noticed in the curves which other observers have published. Lewis ascribes the variations in R and T to reinforcement and interferences between the electromotive forces of the ventricles and the auricles, the latter being in continual activity. Fig. 18 shows, in addition to the usual picture of auricular fibrillation,

Digitized by Google

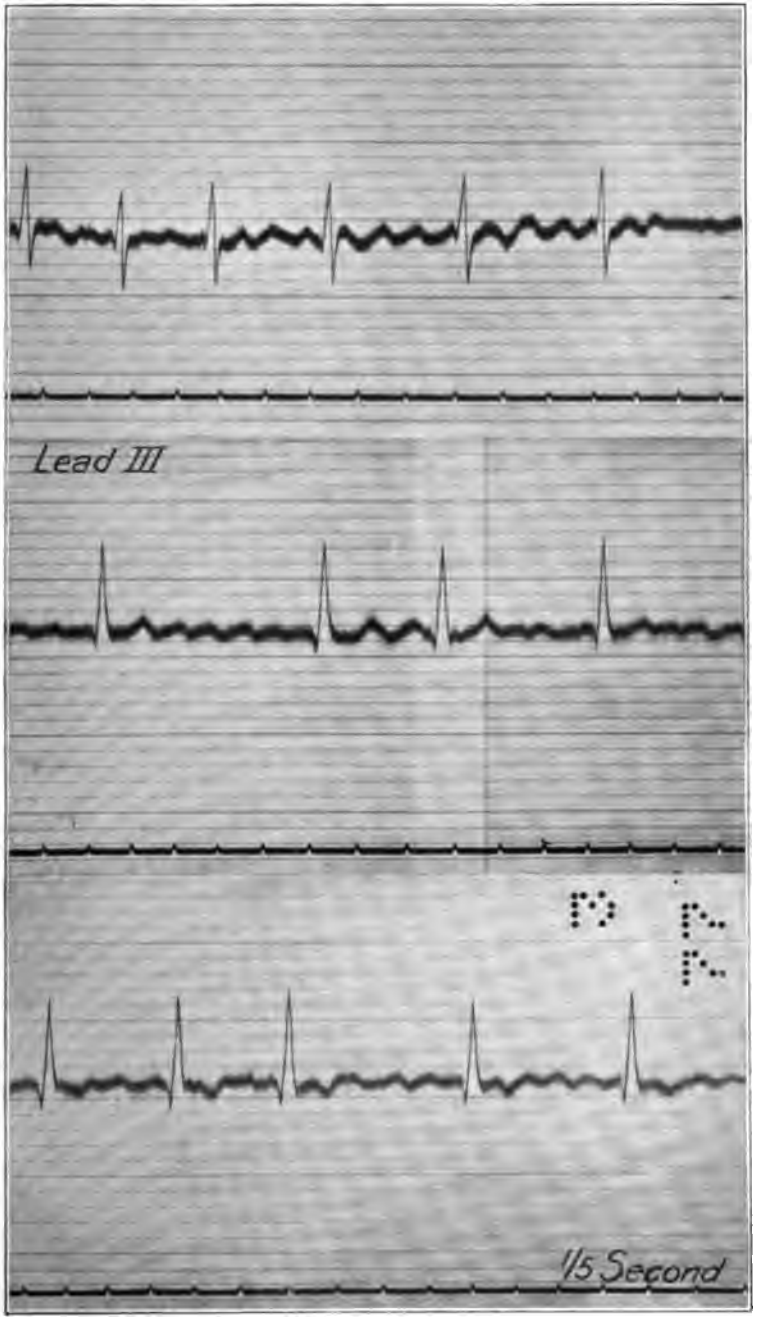


Fig. 17.—Auricular fibrillation in complete irregularity.

Digitized by Google

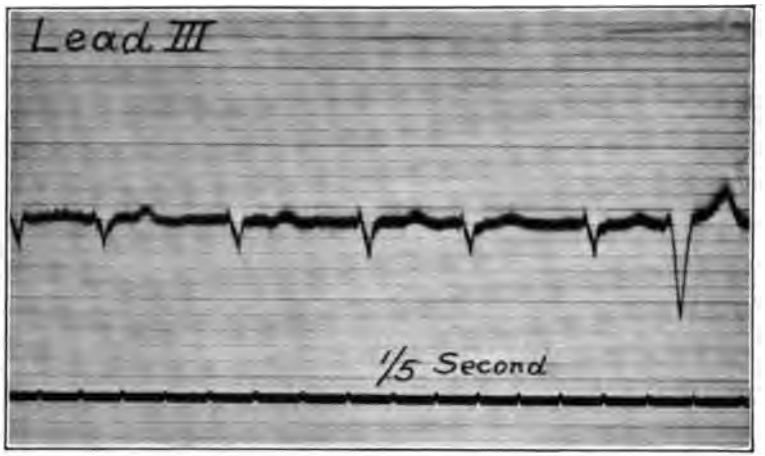


FIG. 18.—Ventricular ectopic beat in complete irregularity.

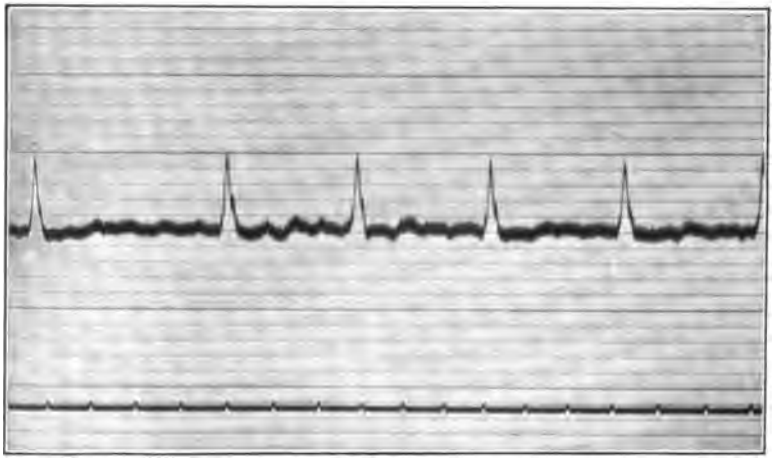


FIG. 19.—Auricular fibrillations in complete irregularity, from a patient in whom the condition produces no disability.

Digitized by Google

ectopic beats originating in the ventricle. Lewis has reported a similar case. He refers to the atypical ventricular beat as an "extrasystole." We suggest that, in view of the fact that no regular auricular rhythm exists in these cases, the avoidance of the term "extrasystole" altogether in this connection would tend to greater clearness of thought.

Though there is sometimes great embarrassment of the circulation in cases of complete irregularity, we do not invariably find great crippling of the circulation associated with this condition. Fig. 19 is an electrocardiogram which presents the characteristic irregularity, and in which the diastolic undulations are especially well marked. For several months prior to the taking of this record the patient's pulse was known to be irregular, and sometimes it has been very rapid—as high as 200 per minute. He has had one attack of dyspnœa. He was perfectly comfortable at the time this record was taken, and at the time of writing he seems, aside from the irregularity of his heart, to be in most excellent health. He has recently been able to enjoy the rather vigorous exercise of an extended fishing trip. The case is of interest on account of the lack of disagreeable symptoms and the almost complete freedom from circulatory disability.

As before mentioned, the underlying cause of the onset of fibrillation is unknown.

Lewis, in his recent communication, has called attention to the fact that in the greater number of instances in which histological study of the heart in cases of complete irregularity has been undertaken, attention has been directed principally to the condition of the nodes and bundle. It is very much to be desired that in all cases in which complete irregularity has been known to exist, and especially in which it has been possible

Digitized by Google

to secure electrocardiograms, careful histological study should be carried out to ascertain the condition of the entire auricle.

Such a case as the one last described leads one to surmise that the lessened cardiac efficiency observed in many patients with complete irregularity may not be due wholly to the abnormal activity of the auricle, but that possibly both the auricular fibrillation and the circulatory insufficiency have a common origin in some fundamental anatomical change.

DISTURBANCES OF CONDUCTIVITY. The electrical method is especially well adapted for the study of disturbances of conductivity, on account of the ease with which the auricular and ventricular phases of the electrocardiogram can be distinguished in nearly all of the records.

So far we have had no opportunity to obtain records from a case of complete dissociation.

Fig. 20 is from a patient who was admitted to the hospital with acute cardiac dilatation, and developed a bigeminal pulse after taking full doses of infusion of digitalis for two days. Aside from the alternation of normal systoles with ventricular extrasystoles, it is noticeable at once that there are very marked variations in the lengths of the P—R intervals, the intervals which represent the time of conduction of the contraction waves from auricle to ventricle.

This effect of digitalis is not uncommon. The patient made a good recovery, and the pulse was normal a few days after this record was taken.

Cases of complete heart block have been reported by Einthoven and others in which the dissociation between auricles and ventricles is clearly distinguishable in the electrocardiograms.

Interesting animal experiments have recently been reported by Eppinger and Rothberger,[46] in which they studied the change

Digitized by Google

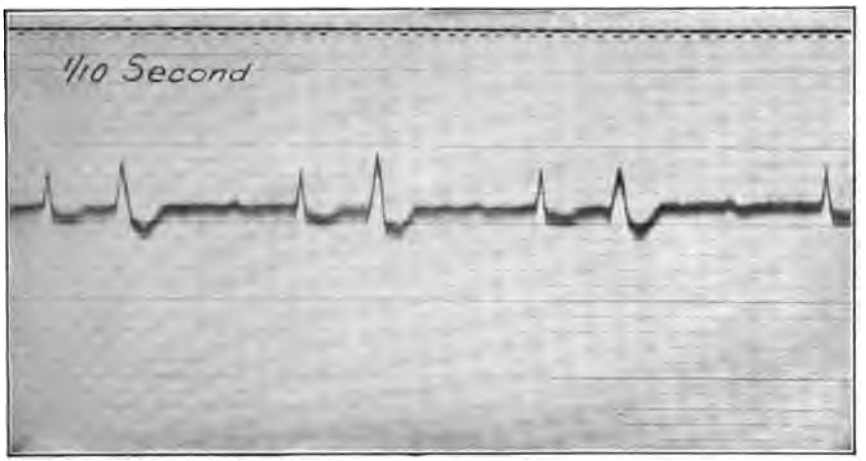


Fig. 20.—Pulsus bigeminus, with disturbed conduction following the administration of digitalis.

Digitized by Google

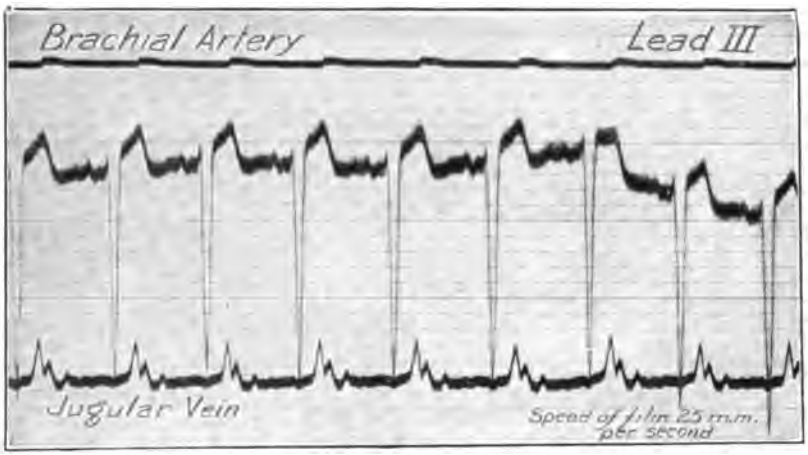


FIG. 21.—Possible lesion of the right limb of the bundle of Tawara.

Digitized by Google

in the electrocardiogram produced by section of the right and left limbs of the bundle (limbs of Tawara). They obtained striking effects. The most notable features of the change were an enormous increase in the electromotive forces of the ventricular phase of the electrocardiogram and a change from the normal complex to a diphasic variation, closely resembling the electrocardiogram of a ventricular extrasystole. The sounds changed to a gallop rhythm. For more detailed information reference must be made to the original article.

Fig. 21 is from a patient with moderate hypertrophy. The percussion outlines were: left border, extreme left limit, 6.5 cm. to the left of the midsternal line; right border, 3 cm. to the right of the parasternal line. He has suffered with increasing dyspnœa for the last five years. The second aortic sound is accentuated, there are no murmurs, but there is a gallop rhythm.

Fig. 21 is his electrocardiogram obtained with lead III. This record is published on account of the marked similarity between it and the records of the experimental lesions of one limb of the bundle just mentioned.

As Eppinger and Rothberger employed the œsophagus-rectum lead, we have chosen lead III of our case for comparison, as it is in the direction of the long axis of the body and corresponds fairly well with the lead they adopted.

It will be seen that the differences of potential are enormous, and that the ventricular electrocardiogram reminds one strongly of a ventricular extrasystole. Each ventricular electrocardiogram, however, is preceded by a normal P wave. The sensitiveness of the galvanometer in this case was determined before and immediately following the taking of the record, and was, as usual, 1 cm., equal to 1 millivolt. A downward directed R III, as we have previously mentioned, is uniformly found with

Digitized by Google

left hypertrophy, but this patient presents only a moderate left hypertrophy and considerable right hypertrophy, which, as we have seen, tends to produce an electrocardiogram with strongly upward directed R III.

These several considerations suggest that in this man there is a lesion in the right limb of Tawara. Such a surmise could only be confirmed by postmortem evidence, and we do not wish to have it understood that we feel justified in making a positive diagnosis of this kind at present; but should events prove this diagnosis correct, it indicates one of the ways in which the electrocardiogram may prove helpful in the diagnosis of obscure conditions.

CONCLUSIONS. The large number of inquiries which have reached us regarding the probable future of the string galvanometer as an aid to clinical diagnosis leads us to believe that, in conclusion, a brief consideration of the matter may not be unprofitable.

As an instrument of precision for original study, the string galvanometer leaves little to be desired. The ease with which it may be adjusted to standard sensitiveness, and the rapidity with which the photographic records may be made, present a striking contrast to the technical difficulties of many physiological methods. Once the apparatus is properly installed, comparatively little skill is required to manipulate it, and this may be readily acquired with practice. In common with all delicate and somewhat complicated physical apparatus, it is liable to occasional derangement, a liability which can be minimized by very careful attention to the original installation. When trouble does occur, it may require a rather intimate knowledge of the physical principles involved to ascertain its nature and make the necessary adjustments.

Digitized by Google

To those who are interested in the prosecution of original study, and who are able and willing to devote a good deal of time to such work, we can recommend the method as well worth while. It seems probable that its most important field of usefulness, so far as clinical medicine is concerned, will be the clearing up of morbid phenomena now little understood, and that once the explanations have been given, the clinician will no longer need this complicated apparatus to enable him to recognize and understand the conditions it has explained.

Just how much information regarding the effect of treatment in disease of the heart can be obtained by the use of this method cannot as yet be stated, but it seems likely that there is opportunity for fruitful work in that direction. Einthoven has employed the galvanometer in connection with a microphone[7] as a means of obtaining graphic records of heart sounds and murmurs. So far we have been unable to carry on investigations of this nature except late at night, on account of the noise of traffic in the neighborhood of the hospital. Given a quiet environment, the method is easy of application.

One of the chief merits of the method is that it makes possible the study of cardiac pathology from the functional as well as the anatomical standpoint.

That the galvanometer may prove a great aid in the diagnosis of an occasional obscure case, experience has shown; but considered simply as an aid to diagnosis, its cost and the time requisite to secure the necessary familiarity with its manipulation will preclude its extensive use.

There can be no doubt of the advantage of having the apparatus installed in large medical centres, where it can be used both as a means of diagnosis and for original work as well.

To those who contemplate the use of the apparatus we cannot too strongly recommend that they spare no trouble or

Digitized by Google

expense to have the original installation properly made. While small and comparatively inexpensive models of the string galvanometer are to be had, which serve a useful purpose in special lines of work, they are to be avoided by those who intend to use the instrument for study of the heart. The small instruments with permanent magnets can only be given the requisite sensitiveness by using a very slack string, and this results in a slower movement, similar to that obtained with the capillary electrometer. Curves thus obtained would require mathematical reconstruction to be available. Still more important is the necessity of an optical system with lenses of high aperture, as only by their use can sufficient illumination be secured to insure good photographic results at high rates of film speed. The amount of light which can be utilized depends solely on the optical system, and, as Einthoven has shown, an increase in intensity of the source of light is ineffective after the capacity of the optical system has been reached.

Westerlund[*] has called attention to the fact that the small instruments with electromagnets are unserviceable for critical work, because the relatively small masses of metal are rapidly heated by the current used to excite the magnets. The result is that the sensitiveness of the instrument varies from moment to moment.

The matter of insulation is of the highest importance. We emphasize this especially because one recent writer has commented on the fact that he secures satisfactory results without much attention to careful insulation. This may be the case for a long time, but sooner or later, often at the time of a critical observation, the lack of care will be regretted. Einthoven has always insisted on the necessity of careful insulation, and our experience bears out the wisdom of his contention. It may be interesting to know that we suffered the greatest

Digitized by Google

annoyance on a damp day from rhythmic deflections of the string, for which we could account only by the assumption that they were telegraphic code. These signals persisted after disconnecting all wires leading away from the apparatus table, and even after disconnecting one end of the string. We found that our table, painted a dead black with carbon paint, was acting as a large capacity and discharging itself into the string. Proper attention to the insulation promptly corrected the difficulty. The source of the rhythmic variations we assumed to be electric waves from nearby wireless stations. We report this to illustrate a source of trouble which may be easily avoided by proper attention to the installation.

Finally, we have already, in the first part of this communication, urged the advisability of the adoption of uniform methods of work by all who engage in the study of electrocardiograms. The subject at best is beset with difficulty, and if each worker adopts a nomenclature of his own it renders far greater the labor of understanding his communications. Uniformity of nomenclature, uniformity regarding sensitiveness of the instrument, and the taking of all three leads will do much to prevent confusion.

[1] Nachweis der negativen Schwankung des Muskelstromes am natürlich sich contrahirenden Muskel. Verhandl. d. phys.-med. Gesell. im Würzburg, 1856, VI, 528 to 583.

[2] A demonstration on Man of Electromotive Changes accompanying the Heart's Beat, Jour. Physiol., 1887, VIII, 229 to 234.

[3] The Electrocardiogram of Man and of the Dog, as shown by Einthoven's String Galvanometer, Lancet, 1909, CLXXVI, 1448.

[4] G. H. Burch, On a Method of Determining the Value of Rapid Variations of a difference of Potential by Means of the Capillary Electrometer, Proc. Roy. Soc., 1890, XLVIII, 89; On the Time Relations of the Excursions of the Capillary Electrometer, Phil. Trans. Roy. Soc., Lond., 1892, CLXXXIII, 81; W. Einthoven, Ueber die form des menschlichen Electrocardiogramms, Pflüger's Archiv, 1895, LX, 102; J. Burdon Sanderson, The Electrical Response to Stimulation of Muscle, Jour. Physiol., 1899, XXIII, 325; Hermann and Gilde-

Digitized by Google

meister, Untersuchungen ber die Eigenschaften und die Theorie des Kapillar-Elektrometers, Pflüger's Archiv, 1900, LXXXI, 491; S. Garten, Ueber ein einfaches Verfahren zu Ausmessung der Capillarelektrometer-Curven., Pflüger's Archiv, 1902, LXXXIX, 613.

[6] Ein neues Galvanometer, Annalen der Physik, 1903, XII, 4 Folge, 1059 to 1071; Die Konstruktion des Saitengalvanometers, Pflüger's Archiv, 1909, CXXX, 287 to 321.

[7] Untersuchungen über thierische Elektricität, Berlin, 1849.

[8] Le télécardiogramme, Archiv. Internat. de Physiol., 1906, IV, 143.

[9] Mittheilung No. 5, Physik-mech. Institut, Munich, 1909.

[10] Ueber das Elektrocardiogramm bei Flimmern der Vorhöfe, Pflüger's Archiv, 1910, CXXX, 391.

[11] Die galvanometrische Registrierung des Menschlichen Elektrokardiogramms, zugleich eine Beurtheilung der Anwendung des Capillar-Elektrometers in der Physiologie, Pflüger's Archiv, 1903, XCIX, 480; Weiteres über das Elektrokardiogramm, Pflüger's Archiv, 1908, CXXII, 526.

[12] Ueber den willkurlichen Muskeltetanus, Pflüger's Archiv, 1907, CXIX, 301 to 337; Zeits. Biol., 1908, 393.

[13] Pflüger's Archiv, 1908, CXXII, 577.

[14] Ueber die Beginn des Papillarmuskelaction und seine Beziehung zum Atrioventrikularbündel, Pflüger's Archiv, 1909, CXXVI, 225.

[15] Das Reizleitungsystem des Säuergetierherzens, Jena, 1906.

[16] The Succession of Events in the Contracting Ventricle, as shown by Electrometer Records (Tortoise and Rabbit), Heart, 1910, I, 3.

[17] Loc. cit.

[18] Weiteres über das Elektrocardiogramm, Pflüger's Archiv, 1908, CXXII, 558.

[19] Einthoven, Weiteres über das Elektrokardiogramm, Pflüger's Archiv, 1908, CXXII, 533.

[20] See page 10.

[21] Le Télécardiogramme, Archiv. internat. de physiol., 1906, iv, 147; Weiteres über das Elektrokardiogramm, loc. cit., S. 553.

[22] The Study of the Pulse, London and Edinburgh, 1902.

[23] Paroxysmal Tachycardia, the Result of Ectopic Impulse Formation, Heart, 1909, I, 262, 282.

[24] Le Télécardiogramme, loc. cit., Plate 3.

[25] Ibid., pp. 151 to 155.

[26] Weiteres über das Elektrokardiogramm, loc. cit., 576.

[27] Kraus and Nicolai, Ueber das Elektrokardiogramm unter normalen und pathologischen Verhältnissen, Berl. klin. Woch., 1907, Nos. 25 and 26; Das Elektrokardiogramm des gesunden und kranken Menschen, Leipzig, 1910, S. 143.

[28] Ueber die functionelle Solidarität der beiden Herzhälften, Deut. med. Woch., 1908, No. 1, S. 1.

Digitized by Google

[36] Henderson, The Volume Curve of the Ventricles of the Mammalian Heart, and the Significance of this Curve in Respect to the Mechanics of the Heart Beat and the Filling of the Ventricles, Amer. Jour. Phys., 1903, XVI, No. 3.

[37] James, A Clinical Study of Some Arrhythmias of the Heart, Amer. Jour. Med. Sci., 1908, CXXXVI, 469.

[38] The Inception of the Rhythm of the Heart by the Ventricles as the Cause of Continuous Irregularity, Brit. Med. Jour., 1904, I, 529.

[39] MacKenzie, the Interpretation of the Pulsations in the Jugular Veins, Amer. Jour. Med. Sci., 1907, CXXXIV, 12 to 34.

[40] The Interpretation of the Positive Venous Pulse, Jour. Med. Res., 1907, XVII, No. 1.

[41] Ueber den Pulsus irregularis perpetuus, Deut. Archiv f. klin. Med., 1908, XCIV, 191.

[42] Das Elektrokardiogramm des Irregularis perpetuus, Deut. Archiv f. klin. Med., 1908, XCIV, 205.

[43] Ueber das Fehlen der Vorhofzacke beim Irregularis perpetuus, Münch. med. Woch., 1909, XLVIII, 2483.

[44] Paroxysmal Irregularity of the Heart and Auricular Fibrillation, Amer. Jour. Med. Sci., 1907, CXXXIII, 66.

[45] Ueber das Elektrokardiogramm bei Flimmern der Vorhöfe, Pflüger's Archiv, 1910, CXXXI, 387; Vorhofflimmern und Arrhythmia perpetua, Wien. klin. Woch., 1909, XVII, No. 24.

[46] Auricular Fibrillation and Its Relationship to Clinical Irregularity of the Heart, 1910, I, 306 to 372.

[47] Le Télécardiogramme, loc. cit., p. 145, Fig. 17, and p. 157, Fig. 31.

[48] Ueber den willkürlichen Muskeltetanus, Pflüger's Archiv, 1907, CXIX, 301; Neue Versuche über den willkürlichen Tetanus der quergestreiften Muskeln, Ztschfr. f. Biol., vol. I, 393 to 420.

[49] Loc. cit.

[50] Das Elektrokardiogramm des gesunden und kranken Menschen, S. 144.

[51] Loc. cit.

[52] Ueber den Pulsus irregularis perpetuus, Wien. klin. Woch., 1909, No. 51, 1792.

[53] Loc. cit.

[54] Ueber der Folgen der Durchschneidung der Tawaraschen Schenkel des Reizleitungs system. Zeitsch. f. klin. Med., LXX.

[55] Die Registrierung der menschlichen Herztöne, mittels des Saitengalvanometers, Pflüger's Archiv, 1907, CXVII, 461.

[56] Ueber einige Beobachtungen mit einem von Edelmann gelieferten kleinen Modell des Einthoven'schen Saitengalvanometers, Skand. Arch. f. Physiol., 1909, XXII, 281.

Digitized by Google

Digitized by Google

III.

ON ACUTE PERICARDITIS IN CHILDREN.*

By David Bovaird, Jr., M. D., Associate Visiting Physician.

Acute inflammation of the pericardium, while not a frequent lesion in childhood, is not uncommon. The subjoined charts illustrate this statement in effective form. The first is drawn from 1,000 autopsies made at the New York Foundling Hospital in about eight and one-half years. It shows 14 cases of acute inflammation of the pericardium occurring at ages varying from six months to three years. The second comprises the cases of acute pericarditis in children observed in the wards of the Presbyterian Hospital during the past four years in a total of about 10,000 patients. The service is, of course, largely composed of adults, but the patients under sixteen years of age number perhaps one-tenth of the total. These tables may be taken to demonstrate that acute pericarditis is not uncommon even in childhood, that it is rarely indeed the primary disease —and that, as we all know, it is a serious affection, and often proves the final catastrophe in severe illness.

Pathology. The pathology of acute pericarditis is so well known that only points of special interest will be mentioned.

The conventional manner of describing several types of pericarditis and denominating them—dry, serous or purulent, or fibrinous pericarditis and pericarditis with effusion—is mis-

*Read before the twenty-second annual meeting of the American Pediatric Society, Washington, May 5, 1910.

(*Reprinted from the Archives of Pediatrics*, 1910, *p.* 760.)

Digitized by Google

leading. Acute pericarditis, we may say, is always marked by swelling of the pericardium and an effusion upon its surface or into the sac. This effusion consists of fibrin, serum and leukocytes in varying proportion. If the serum is scanty and the fibrin abundant, there is little or no fluid in the sac, and the pericardium is coated with a plastic exudate, we speak of the pericarditis as dry or fibrinous. If the serum is more abundant, so that it distends the pericardium, the process is denominated pericarditis with effusion or sero-fibrinous pericarditis. And if the polynuclear leukocytes in the fluid become abundant and undergo degeneration, we speak of a purulent pericarditis.

For a clear understanding of these conditions it seems very desirable to emphasize the well-established fact that these several varieties of pericarditis are but steps in the process of reaction of the pericardium to the assaults of certain noxae, toxins or bacteria. The dry pericarditis of one day may be a pericarditis with effusion the next, and the effusion may eventually prove to be either serous or purulent.

Certain characters of the exudate in acute pericarditis are of practical importance. The amount of fibrin in the exudate varies greatly. In many cases there is sufficient only to coat the pericardium and give it a slightly granular or rough appearance. In other cases the fibrin is so abundant as to cover the heart with a thick plastic layer which may be as much as a centimeter in thickness. The pericardium may therefore be considerably distended and the total width of the area of cardiac dullness greatly increased without the presence of fluid in the sac, and an exploring needle, though it enter the sac, may fail to obtain fluid. In certain cases where pus is present, it may, for like reasons, be obtainable only by an exploring needle of large caliber. The close resemblance in this regard between

Digitized by Google

effusions of the pleura and pericardium in children is very striking.

It is not uncommon in severe cases to observe minute hemorrhage into the pericardium itself, and hemorrhagic exudates are frequently seen. Von Starck[1] records 4 cases of bloody effusion in rheumatic cases, and our own experience would lead us to believe that the presence of blood is not infrequent in non-tubercular conditions. Chylous effusions are practically unknown in childhood.

The disposition of the effusion with relation to the heart itself is of importance. The conception that the fluid in pericarditis is evenly distributed about the heart is certainly not correct. The fluid tends to accumulate in the lowermost parts of the sac, that is, with the patient supine, in the lower or posterior part. The anterior surface of the heart may therefore be but scantily covered when a considerable quantity of fluid lies behind the heart.

For this reason the effect of the effusion is to distend the pericardial sac downward and backward and there is little or none at all of the assumed floating of the heart itself upward.

It is also clear that the fluid in pericarditis does not quickly or readily change its distribution, and one fails to observe very prompt response in physical signs to changes of position, such as are possible under the usual conditions. When, however, it is feasible to put the patient in the knee-chest position, an increase in the area of cardiac dullness, not previously observed, may be obtained.

In many cases of pericarditis the myocardium as well is involved and inflammatory or degenerative changes may be demonstrated in it. Beyond doubt the consequent weakening of the cardiac muscle plays a part in causing circulatory failure,

Digitized by Google

and in many cases relaxation of the cardiac chambers is one element in the enlarged area of cardiac dullness.

Associated Lesions. The table of observations from the Foundling Hospital is of interest, showing, as it does, that in every instance but one the recorded pericarditis was accompanied by pneumonia, or pleurisy, or both. The one exception (enterocolitis) is sufficient, however, to support the clinical experience that such association is not inevitable. It is also notable that in these cases the pericardial effusion in 11 out of 14 cases was purulent, and in the remaining 3 sero-fibrinous. In fatal cases we expect the severer lesion, but the frequency of suppurative pericarditis is important.

In early childhood the type of pneumonia seems to be of little importance, lobar and bronchopneumonia both being found together with pericarditis.

The pleural inflammation may be of any grade, fibrinous, serous, or purulent, and it is well known that the two membranes being anatomically of like structure react similarly to any infection and the conditions found in pleura and pericardium in any one case are regularly the same.

Relation to Tuberculosis. In view of the common teaching of the frequency of tuberculous pericarditis, the absence of tuberculosis from the list of conditions associated with or accompanied by pericarditis may excite surprise, but so far as the writer's knowledge goes, the facts are properly stated. In 125 cases of tuberculosis in children under the age of seven years, examined in the postmortem room of the New York Foundling Hospital, tubercles were found in the pericardium of 4 cases, and in the heart muscle in 1, but in none of these cases was there effusion or any other evidence of acute pericarditis.

Digitized by Google

Clinical experience also corroborates these postmortem findings, for I cannot now recall ever having known a case of pericarditis in a patient under sixteen years of age to be proven by reliable evidence to be tuberculous. It is not, of course, meant to deny the possibility that tuberculosis may produce pericarditis in children, as it is well known to do in adults, but simply to indicate that the tubercle bacillus is very rarely indeed found in this relation.

Bacteriology. Unfortunately in the Foundling Hospital cases no cultures were made, but studies made in the Presbyterian Hospital show that in the pericardial exudates (especially the suppurative) the pneumococcus is most often found, as the frequent association of pneumonia and pleurisy would lead one to expect. Staphylococci or streptococci are occasionally found, but other bacteria (gonococcus, etc.) are very rarely met with.

Bacteria are, of course, most frequently found in purulent exudates. They may, however, be demonstrated in serous or fibrinous effusions. The frequency with which the serous exudates are sterile is noteworthy. Also it must be remembered that the evidence is altogether that these sterile exudates are not tuberculous, but belong for the most part in the rheumatic class.

Poynton and Payne have obtained their "streptococcus rheumaticus" from the pericardial exudate in cases of rheumatic fever, but this we have never been able to do.

Symptomatology. Of the symptoms of acute pericarditis but little will be said, since they are of relatively small importance to the diagnosis.

Dry pericarditis gives rise to very little disturbance, and its onset is marked by the symptoms of the primary condition.

Digitized by Google

There may be discomfort or pain, although in many cases the friction of the inflamed surfaces seems to be scarcely appreciated, and some moderate increase in the pulse or temperature.

With an increasing effusion dyspnea, or orthopnea, cyanosis, and rapid, irregular and intermittent action of the heart develop.

The temperature varies with the nature of the effusion, and may be low or high. In the septic cases there are high fever, pallor of the skin with cyanosis, and frequently profuse sweating. As in nearly all cases the pericarditis is accompanied by acute inflammations of other parts, the heart, the pleura, the lungs, etc., it is quite impossible to satisfactorily determine the relationship of lesions and symptoms.

While in most cases acute pericarditis is a rapid process, quickly evolving its symptoms and physical signs and rapidly producing a crisis in the patient's condition, it is well known that in some instances the onset is insidious. Coutts[3] has reported a case in which a four-year-old child had been sick for ten weeks before being brought to the hospital, and lived seven weeks longer, with a purulent effusion in the pericardium, which he regarded as primary. During this long period there was nothing in the clinical picture to direct special attention to the pericardium.

Physical Signs. These are the rational signs, first, of a roughening of the serous covering of the heart and then of its distention by accumulating fluid. In dry pericarditis we have the characteristic to and fro rub. When an effusion collects we have the bulging precordium, an increased area of cardiac dullness, enfeebled or lost apex beat and auscultatory sounds, and finally dullness in the cardiohepatic angle, as was years ago demonstrated by Rotch.

Digitized by Google

Taking the physical signs in conjunction with symptoms of serious illness it would appear that the diagnosis of acute pericarditis in childhood should be readily made. Yet every one knows that the contrary is the fact and that there is no other grave malady so frequently discovered for the first time in the postmortem room.

For the explanation of this situation there are several facts of importance. First of all, that acute pericarditis is a secondary affection, and secondary to some serious primary disease, such as a septic infection, pneumonia, acute rheumatic fever, and the like. The severe symptoms of the primary affection mask the onset of the inflammation of the pericardium. The patient's condition changes for the worse, but the change can readily be explained as the augmentation of the symptoms of the primary disease.

Secondly, the physical signs may be notably modified or obscured by attendant conditions. The pericardial friction sound is justly regarded as a most significant sign of acute pericarditis. Its presence most often first calls attention to the fact that the pericardium is involved and leads to more careful observation. Yet it must be admitted that acute pericarditis can develop and go on to effusion without its being possible, even by the most careful and repeated observation, to detect the characteristic rub. During the last year we had under our care in the Presbyterian Hospital a boy of ten years, whose primary disease was pneumonia, complicated later by a left-sided empyema. The pleura was opened and drained, and yet the patient did not improve. Day after day most careful study of the heart was made both by myself and an alert house staff. No friction sound was heard at any time, and yet at autopsy a heavy layer of fibrinous deposit was found covering the pericardium. This thick, plastic type of exudate, covering, as it

Digitized by Google

does, the surface of the heart evenly, gives neither the characteristic friction rub nor those of fluid, and is most often overlooked in consequence.

The conditions in the patient to whom reference has just been made well illustrate the second great difficulty, as regards the physical signs of pericarditis, namely, that they are often obscured by the attendant conditions.

It was observed for some days that the limit of cardiac dullness on the right of the sternum was displaced distinctly to the right. This was at first assumed to be due to the empyema, and when it persisted after the opening of the pleura we failed to attribute due importance to it. The presence of the empyema on the left side naturally obscured the limits of cardiac dullness in that direction and left us only the apparent displacement of the cardiac dullness to the right to interpret.

In a similar manner a pleural effusion on the right, a pneumonia, an enlargement of the liver, a marked abdominal distension displacing the liver and diaphragm upwards, or still more commonly the noisy respiration or restlessness of an extremely sick child make observation difficult or misleading.

Recognizing that in this situation any aid to diagnosis will be welcome, I venture to direct attention to a new method of studying old signs with relation to the diagnosis of pericarditis with effusion or serum or pus, the conditions of most vital importance, a method learned from following the careful clinical studies of Dr. Francis P. Kinnicutt.

Increase in the area of absolute cardiac dullness has long been known as one of the most important signs of these conditions. Also that the increased area of dullness had a characteristic form, that of a truncated triangle, the broad base below, the truncated apex above.

Digitized by Google

FIG. 1—Acute Pericarditis, showing the area of cardiac dullness at its maximum. The symmetry of distention is striking. This has been observed in other cases.

Digitized by Google

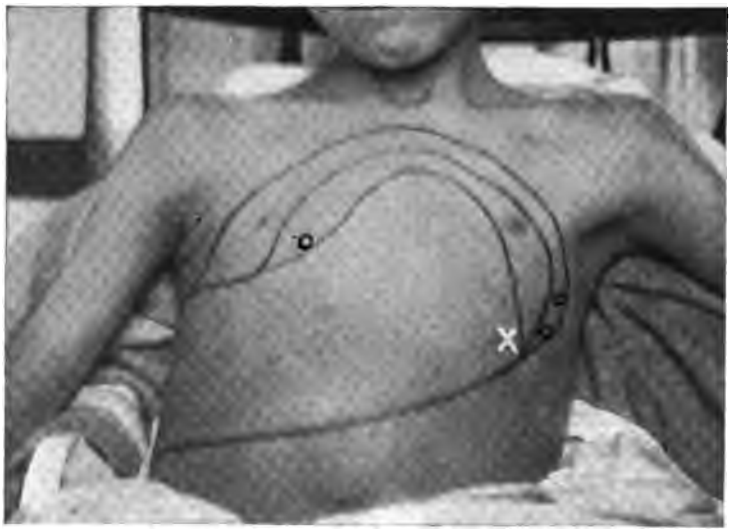


FIG. 2.—The same patient, showing outlines of cardiac dullness at successive stages of resorption fusing below into area of liver dullness. The outlines shown correspond closely to those observed during the accumulation of the fluid.

Digitized by Google

The point which the experience of recent years has impressed upon us as of peculiar value is that careful observation will demonstrate, in any case of pericardial effusion large enough to be of consequence, a *progressive* increase in this area, and that such *progressive* increase constitutes the most reliable evidence of a pericardial effusion. (See illustration.)

The detection of progressive increase in the area of cardiac dullness implies the repeated careful examination of the heart and the recording of results in some more or less permanent form for later comparison. The outline of cardiac dullness may be plotted on the chest wall, measurements from the mid-line recorded and the findings from day to day compared. But it is immensely more effective if the outline of cardiac dullness can be marked upon the chest wall in some form that will show the changes from day to day. We have done much experimenting in search of a suitable method. The outline may be marked in ordinary ink and renewed from time to time as necessary, but we find that such marks are readily smudged or removed entirely by the nurse's ministrations. Nitrate of silver may be employed, but is so difficult to handle and so likely to cause excoriation, if used too freely, that it has not been found satisfactory. Lately some experiments with the ordinary forms of indelible inks have shown that marks made upon the skin with them are more lasting and satisfactory than those made by any other method we have thus far been able to devise.

If, in every case of pneumonia, pleurisy, acute rheumatism and the like in which pericarditis may develop, by some such means the apex beat of the heart and the outlines of the cardiac dullness are marked clearly on the thoracic wall, we shall much more quickly than otherwise note any shifting of the apex beat or its disappearance and any subsequent changes in the area of cardiac dullness. The guiding marks are before our eyes.

Digitized by Google

Furthermore, we shall have much more confidence in them than in measurements recorded in the history, which may easily be wrongly made or wrongly recorded.

With such guides the limits of cardiac dullness may be found to shift in the course of a few hours to a very appreciable extent. It is, of course, not the shifting of the limit of dullness on the right or left that is significant, for either alone may be produced by displacement of the heart. It is the outward displacement of dullness on both sides that marks and measures the increasing effusion. Incidentally in following this broadening of the area of dullness we shall appreciate all the more forcibly the dullness in the cardiohepatic angle, and the fact that while the cardiac dullness is increased in all directions the greatest increase is along the base line, *i. e.*, on the diaphragm.

Dilatation of the heart, it may be objected, may give rise to exactly similar enlargement. Granted, theoretically; but practically the objection carries little weight. Dilatation also is an enlargement of either right or left ventricle, rarely indeed simultaneously of both, and therefore has not the symmetrical form of pericardial effusion. In our experience dilatation, unless caused by pericarditis, never occurs in the progressive manner characteristic of the pericardial effusion. Furthermore, the chance of error is removed by observing that the increasing dullness is most marked along the diaphragm and especially in the cardiohepatic angle.

In doubtful cases where the diagnosis is of the utmost importance, it has been found that the area of cardiac dullness in the course of twelve or twenty-four hours will show changes which are decisive. Observation over night or for a day will therefore satisfy one of the presence or absence of pericardial

Digitized by Google

effusion and also give exact important evidence with relation to the question of treatment.

Broadbent and Poynton[3] both state that such gradual increase in the area of cardiac dullness, associated with dullness in the cardiohepatic angle, may be due to increasing cardiac dilatation, but this the writer has never observed save in the cardiac dilatation resulting from acute pericarditis and accompanied by pericardial effusion.

It should, of course, be understood that the emphasis put upon this particular sign of pericardial effusion is not meant to deny the value of other signs, especially the pericardial friction and the progressive weakening of the apex beat and the heart sounds.

The disappearance of a previously heard pericardial friction may be expected with an increasing effusion, but does not always follow. Owing to the tendency of the fluid to gravitate to the lowermost part of the pericardium, the upper part may still remain in contact, and the pericardial friction persist even with large effusions. Just where the friction will be heard under these circumstances will depend upon the posture of the patient and the disposition of the fluid.

Signs Over the Left Lower Lobe.—As a collateral sign of pericardial effusion Pins, of Vienna, long ago pointed out evidences of pressure exerted upon the left lower lobe of the lungs and these signs have been repeatedly studied by other observers. Ewart[4] outlines the area of dullness produced in this manner as bounded by a line drawn outward from the vertebral column at the level of the ninth and tenth ribs and a perpendicular line dropped from the vertebral border of the scapula. Below the dull area reaches the base of the chest and internally is bounded by the vertebral column or it may pass

Digitized by Google

slightly to the right of it. Over the dull area the voice and breath sounds are diminished or absent.

Without doubt in most cases of large pericardial effusion one finds dullness with some modification of the voice and breath sounds, either intensification or diminution, below and internal to the angle of the scapula. Rarely, however, are the signs delimited with the exactness laid down by Ewart's boundaries. The interpretation of these signs is not easy. A partial consolidation of the lung, a pleural effusion, or compression of the lung by the distended pericardium may account for them. The arguments by which Fetterolf and Landis[1] explain the hydrothorax of cardiac dilatation by pressure upon the pulmonary veins are of interest in this relation. The distended pericardium undoubtedly exerts pressure upon the left bronchus and the lower pulmonary veins, and partially compresses the surrounding lung. But the surrounding lung comprises the upper lobe and the upper part (apex) of the lower lobe, and not the part of the lung corresponding to the area of dullness marked out by Ewart. In brief the compression affects the apex of the lower lobe, while the physical signs are at the base.

Furthermore, we have all, I am sure, followed the gradual evolution of these basal signs of pericardial effusion from day to day, till we have become satisfied of the presence of an effusion in the left pleura, and aspirating it have obtained more or less fluid. To determine the presence or absence of fluid in the left pleura under these conditions, *i. e.*, with a distended pericardium and the physical signs mentioned at the left base, is most difficult. The extent of the dullness and the diminished voice and breath sounds is probably of most importance. In any case with extensive dullness exploratory puncture of

Digitized by Google

the pleura is called for, in the hope that fluid may be formed and partial relief obtained by its withdrawal.

The studies of Fetterolf and Landis, above spoken of, explain the hydrothorax accompanying cardiac dilatation by the pressure of the enlarged heart upon the pulmonary veins, with consequent stasis in, and serous effusion from, the pulmonary pleura. The same explanation may apply to the physical signs and serous effusion so regularly found at the left base in cases of pericardial distention by fluids.

Neither in the discussion of the physical signs or pericarditis with effusion, nor with reference to the signs at the left base, has mention been made of the information to be had by changes in the position of the patient. It has been claimed that by turning the patient from side to side, or moving him from the recumbent position to the upright, or even from the recumbent attitude to the knee-chest position, valuable information may be obtained with reference to the physical signs and their interpretation. In the great majority of the cases of pericardial effusion, however, the patient is too sick and too uncomfortable to permit of much movement, and efforts to make such comparisons have, in our experience, been of little or no value.

The subject of the diagnosis of pericardial effusion cannot be dismissed without reference to the use of the X-ray. The possibilities of this agency in the diagnosis and study of cardiac lesions in the adult have been fully demonstrated by the remarkable work of Groedel and others. Because of the greater penetrability of the thorax children offer still better opportunities for such study than adults, and yet thus far but little work has been done in this field. Particularly with relation to pericardial effusion in children, it appears that the X-ray may offer invaluable information, displaying as it does not only the limits of the distended pericardial sac, but the posi-

Digitized by Google

tion of the heart in the sac itself, so that if aspiration is contemplated the site of puncture may be chosen in confidence that the heart will not be touched.

These possibilities, which to most of us have been a dream, have been translated into fact by the pioneer work of Rotch, but a few weeks ago presented to us in his new and most interesting volume, the "Roentgen Ray in Pediatric Practice." In that work are three beautiful plates illustrating the points just stated. The difficulty of obtaining radiographs of severely sick patients has prevented the general use of them in cases of pericarditis, but if such invaluable information can be obtained by this means the difficulties must be overcome, especially as Rotch has apparently demonstrated that they can be.

Aspiration of the Pericardium. Withdrawal of fluid from the pericardium by a syringe or the aspirator may be undertaken either for diagnostic or therapeutic purposes. Serious objection has of recent years been made to the procedure as so dangerous as to be unjustifiable, and it has been urged that if the pericardium is to be entered it should be done by incision under cocain, so that the operator may see clearly what he is doing. The strength of this position is not to be denied. Attempts to aspirate the pericardium have too often proved aspirations of the heart, and death has more than once resulted from the procedure. Various writers speak of having penetrated the heart and drawn blood from it without harm. In the physiologic laboratory blood is drawn from the calf's heart with a canula several times the caliber of an aspirating needle and the canula withdrawn without harm. On two occasions, however, I have seen the heart of an adult punctured and hemorrhage into the pericardium caused with fatal consequences. As it happened, both patients would undoubtedly have died in

Digitized by Google

any event, but the gravity of puncturing the pericardium with an aspirating needle has been deeply impressed upon me. And yet to wholly disregard the procedure because of this danger seems unwise. If exploration of the pericardium is to be undertaken only as an open surgical operation, a limitation will be put upon its use which in the end will work more harm than the older procedure. Moreover, it is possible by adequate care in our observations to make practically certain the diagnosis of pericardial effusion and to practice aspiration with safety. This is especially true in childhood for reasons already pointed out, and in the many aspirations of the pericardium in children which I have seen or done no serious mishap has occurred. Finally, if the Roentgen rays can be employed and such plates as Rotch's obtained, aspiration of the pericardium can be rendered entirely safe.

Scope of Paracentesis. A wholesale fear of the use of the aspirating needle in the pericardium has undoubtedly limited its employment. Exploratory puncture must be employed more freely if we are to recognize and treat properly (by drainage) the suppurative conditions which are not uncommon. The nature of the antecedent infection, rheumatic fever, pneumonia, septicemia, cannot be relied upon to determine the nature of the effusions. Suppurative pericarditis has developed in rheumatic conditions and serous effusions been found in pneumonia and septicemia.[4] Since suppuration demands drainage, safety can be had only by knowing the character of the fluid present in the pericardium, unless we are ready to say that all effusions in the pericardium should be drained.

Secondly, paracentesis may be required for therapeutic purposes. There is a general tendency to rely upon natural processes for the absorption of serous effusions, particularly in

Digitized by Google

rheumatic cases. English writers agree that aspiration in these cases is rarely required, and Poynton says that he has never seen a case of rheumatic pericarditis require such intervention. That view must be extreme. Certainly one sees fatal cases of rheumatic fever in which pericardial effusion is one element in the untoward outcome, and also from time to time one sees rheumatic patients suffering from endo- and pericarditis, and apparently in extremis relieved and helped toward recovery by removal of fluid from the pericardium.

Site of Aspiration. The fourth or fifth interspace close to the sternum was first selected for this purpose on the theory that the heart was floated upward by the pericardial effusion. Rotch demonstrated the falsity of this conception, and on the basis of his studies recommended reaching the pericardium through the fifth right interspace. Of recent years a point outside the apex and yet within the area of dullness of the distended pericardium has been advocated by West and others. To either of these sites the objection may be urged that to reach the pericardium, the overlying pleura (left or right as the case may be) must be penetrated. The great point in favor of one or the other is that they undoubtedly offer less chance of injuring the heart. This fact, supported by theoretical considerations and practical experience, is demonstrated beyond doubt by the radiographs already spoken of. With any considerable effusion into the pericardium there is space on either side of the lower or diaphragmatic border of the heart between the two layers of pericardium occupied only by the effused fluid. Puncture in either of these spaces, so long as it is made in a plane parallel to the median plant of the body, *i. e.*, with the needle parallel to that plant, ought to be entirely safe. Danger arises whenever the needle is given an oblique direction, and

Digitized by Google

the operator is left to try to calculate the position of the point from the line of direction and the length of the needle. Owing to the fact that the distended pericardium is practically always outside the nipple line on the left, puncture outside the apex must be made on the shelving side of the thorax, and it is extremely difficult to avoid a definite inward inclination of the needle with resulting danger of transfixing the apex or the right ventricle of the heart. Furthermore, if the heart is pierced under these conditions the active motion of the affected part (the most active of any part of the heart) tends to enlarge the puncture into a linear wound which is sure to bleed. The two serious results which I have seen in adults were to be explained on these grounds. On the other hand, West' objects to the fifth right space as the most dangerous of all, because of the neighborhood of the thin walled right auricle. I have safely used both sites, in one instance obtaining the fluid by puncture outside the apex after having failed in the fifth right space, but for the reasons given I have a distinct preference for the latter site.

Prognosis. The outcome in any case of acute pericarditis in childhood depends, for the most part, (1) upon the primary disease, (2) upon the amount of effusion, and (3) upon the character of the effusion, whether serous or purulent.

The primary disease and the character of the effusion are usually closely connected. In rheumatic infection the effusion is regularly fibrinous or serous. In septicema, pneumonia, pleurisy and the like it is most often purulent, but may be serous or sero-fibrinous.

The pure fibrinous or serous exudates regularly resolve with the formation of adhesions. In the rheumatic cases there is a notable tendency to recurrence of the inflammation of the heart

Digitized by Google

and the pericardium, with an ultimate development of chronic endocarditis and chronic adhesive pericarditis. In hospital practice children suffering from these conditions regularly return year after year, and sooner or later surely succumb to cardiac failure. In private practice results are better, but even under the best conditions it is difficult to prevent recurrences, and the prognosis, so far as concerns active, healthful life, is gloomy.

Suppurative pericarditis in children is fatal in nearly all instances, yet recoveries under appropriate surgical treatment have been recorded. In Eliot's[8] tabulation of 22 cases of suppurative pericarditis treated by operation, one of the patients was sixteen years of age, and 7 under that age. Of these 1 recovered. This patient was a girl, five years old, who, after a tonsillectomy, developed a left-sided empyema and later suppurative pericarditis. The pleura was first opened and later the pericardium was drained through the empyemic cavity. The child made a prompt recovery. In several of the other cases distinct improvement followed the draining of the pericardium, but the patient died of some further extension of the infection.

The following case illustrative of several of the points made in this paper may here be cited.

J. H., a boy of ten years, was taken sick March 14, 1909, and on admission to the Presbyterian Hospital five days later (the 19th) was found to have a lobar-pneumonia of the left lower lobe. He had the usual high fever, rapid pulse and respiration of that condition. Two days later, in the evening, the patient became very restless and tossed about his bed continually. Examination of the cardiac area showed an extension of the cardiac dullness on both right and left borders of the heart, and a friction sound was heard in the cardiohepatic angle and along the left border. The pulse had risen from 144 to 160, but there was no notable change in the temperature or respiration. The heart sounds were distinct. Twelve hours later (the next morning) the limits of cardiac dullness were further displaced outward, especially on the right, where the line of dullness was outside and above the right nipple, and

Digitized by Google

the cardiohepatic angle was broadly obtuse. The heart sounds were fainter. The friction sounds could still be heard over the upper part of the cardiac area. An aspirating needle inserted in the fifth right space about one inch from the sternal margin withdrew pus. The same morning Dr. Eliot resected a portion of the fifth left costal cartilage, opened the pericardium and inserted a drainage tube. Although little pus was discharged at the time of operation, an abundant discharge occurred shortly afterward. In every way the child's condition improved for several days, when the right pleura was found to contain pus and was in turn opened and drained. Even under those conditions the child rallied and improved for a time, but died on April 4th, thirteen days after the opening of the pericardium. The pneumococcus was found in both pericardial and pleural exudates.

The apparent hopelessness of these cases should urge us to more careful observation and study, that by early diagnosis adequate treatment may be undertaken as promptly as possible, and the great danger of death, if possible, averted.

The quantity of the exudate, be it serum or pus, has a definite relation to the prognosis. The studies of Haven Emerson[9] on the effects upon the circulation of fluid (water) injected into the pericardia of dogs have apparently proven that the weak and irregular heart action and falling blood pressure produced by increasing pressure in the pericardial sac is due not so much to the direct effects of the pressure upon the heart itself as to the mechanical cutting off of the return of blood to the heart by pinching or compressing the superior and inferior cava within the pericardium. By reason of this obstruction blood enters the heart with difficulty, the chambers are improperly filled, and the heart exhausts itself in a vain effort to maintain the falling blood pressure.

These studies indicate that whatever the nature of the pericardial effusion, if it be accompanied by low blood pressure and weak, irregular heart action, the pressure within the pericardial sac should be lowered, either by aspiration or drainage.

Digitized by Google

Treatment. Rest in bed, careful feeding and nursing are, of course, the essentials. The primary disease must be treated. It is doubtful whether even in the rheumatic cases our remedies have direct influence upon the pericardial inflammation, but the free administration of salicylates has often seemed to check the process. Opium or morphin is of service for the relief of pain and distress. Children, as a rule, object to the application of cold, and the ice-cap seems to have but little effect.

The question of greatest importance is the amount and character of the fluid present. We can estimate the amount from the physical signs and the evidence of interference with the heart action. The character may in many cases be inferred from the nature of the primary process, but not with surety. With any large effusion it is, therefore, safest to ascertain the character by an exploratory puncture.

Rheumatic effusion will, as a rule, resolve naturally, but certainly removal of the fluid relieves distress and hastens recovery, just as it does in the case of the pleura. With large effusions, aspiration is therefore desirable, and if the conditions are thoroughly studied can be safely done. The removal of even a few ounces of fluid brings definite relief and, in my judgment, earlier recovery.

If the effusion is purulent open drainage is required. For this purpose a portion of the fifth, sixth or even seventh costal cartilage on the left side may be removed, and the drainage tube inserted. Even with such treatment the chance of recovery is small. It will be increased only when we learn to control the primary infections or to make the diagnosis earlier and more promptly institute proper treatment.

Digitized by Google

TABLE I.

CASES OF ACUTE PERICARDITIS FROM THE AUTOPSY-RECORDS OF THE NEW YORK FOUNDLING HOSPITAL.

No.	Sex	Age	Associated Lesions	Type of Pericarditis
1	Male	9½ mos.	Pleurisy, serofibrinous, and infarctions of lungs	Serofibrinous
2	Male	2½ yrs.	Pleurisy, fibrinopurulent, and lobar pneumonia	" "
3	Male	3¾ yrs.	Empyema	Purulent. Pus, 8 ounces
4	Female	6 mos.	Empyema and bronchopneumonia	"
5	Male	1¾ yrs.	" " " "	"
6	Male	9 mos.	Diphtheria and lobar pneumonia	"
7	Male	1 yr.	Empyema	"
8	Male	2 yrs., 7 mos.	Empyema and lobar pneumonia	"
9	Male	7 mos.	Acute enterocolitis	"
10	Male	9 mos.	Bronchopneumonia	"
11	Female	3 yrs.	Diphtheria, Bronchopneumonia, Empyema	"
12	Male	11 mos.	Bronchopneumonia, fibrinous pleurisy	"
13	Male	6 mos.	Bronchopneumonia, fibrinous pleurisy	Serofibrinous
14	Female	10 mos.	Bronchopneumonia, seropurulent pleurisy	Purulent

TABLE II.

ACUTE PERICARDITIS.—CLINICAL RECORDS OF THE PRESBYTERIAN HOSPITAL, 1906-1910.

1	Male	12 yrs.	Chronic Endocarditis	Serofibrinous. Adh. Peri'dium	D.
2	Male	15 yrs.	Septicemia Empyema	Purulent	R.
3	Female	3½ yrs.	Rheumatic Fever. Endocarditis	Fibrinous	D.
4	Female	8 yrs.	Rheumatic Fever. Endocarditis	"	R.
5	Male	16 yrs.	Rheumatic Fever. Endocarditis Lobar Pn.	Serofibrinous	R.
6	Male	13 yrs.	Rheumatic Fever. Endocarditis	Serofibrinous. Adh. Peri'dium	R.
7	Male	10 yrs.	Rheumatic Fever. Endocarditis	" " "	R.
8	Male	16 yrs.	Endocarditis Chr.	Fibrinous	R.
9	Male	7 yrs.	" "	Serofibrinous " "	R.
10	Female	10 yrs.	" "	Fibrinous " "	R.
11	Male	8 yrs.	" "	Serofibrinous	R.
12	Female	10 yrs.	" " Lobar Pn.	" "	R.
13	Female	4 yrs.	" "	Fibrinous	R.
14	Male	10 yrs.	" "	"	D.
15	Male	7 yrs.	Lobar Pneumonia	Suppuration	D.
16	Male	11 yrs.	" " Empyema	"	D.
17	Male	14 yrs.	" " Pleurisy Fibrinous	Fibrinous	D.
18	Female	7 2-3yrs	Lobar pneumonia, Pleurisy Fibrinous	Serofibrinous	D.

[1] Von Starck, Jahrbuch für Kinderheilkunde, 1895, Vol. XL, pp. 70-77.

[2] Coutts, British Medical Journal, 1903, Vol. II, p. 359.

Digitized by Google

[3] Broadbent, "Heart Disease," fifth edition, 1906, p. 34.
Poynton, "Heart Disease and Thoracic Aneurism," 1907, p. 170.
[4] Ewart, see Poynton's work, p. 171.
[5] Fetterolf and Landis, Am. Jour. Med. Sc., 1909, Vol. CXXXVIII, p. 712.
[6] Poynton, "Heart Disease and Thoracic Aneurism," p. 168.
[7] West, London Med. Jour., 1908, Vol. XIII, p. 21.
[8] Eliot, Annals of Surgery, 1909, p. 61.
[9] Personal communication.

Digitized by Google

IV.

MENINGOCOCCUS ENDOCARDITIS, WITH SEPTICEMIA.

ITS BEARING ON THE MODE OF INFECTION IN EPIDEMIC CEREBROSPINAL MENINGITIS.*

By Russell L. Cecil, M.D., Assistant Visiting Physician, and Willard B. Soper, M.D., Pathological Externe.

Meningococcus septicemia was first reported by Gwyn[1] in 1899. The case was one of epidemic meningitis complicated by acute arthritis. The meningococcus was isolated from the spinal fluid, synovial fluid, and the blood. Cochez and Lemaire[2] in 1901 were able to demonstrate the meningococcus in the blood of two meningitis patients. Jakobitz,[3] Martini and Rohde,[4] Lenhartz,[5] Marcovitch,[6] Robinson,[7] and Duval[8] have since made similar reports, the septicemia in all these cases being associated with meningitis. Elser,[9] examining the blood in forty-one cases of cerebrospinal meningitis, found the meningococcus in ten, or about 25 per cent. It has been observed that in most instances where the meningococcus has been found in the circulating blood, the disease has been fatal, and some form of extrameningeal lesion has been present. The endothelial-lined cavities, such as the joints, pleura, pericardium and endocardium have been the sites of these complicating lesions. Duval[8] in his study of meningococcus septicemia makes the statement that no authentic cases are on record in which the

* (*Reprinted from the Archives of Internal Medicine, July*, 1911.)

Digitized by Google

meningococcus has produced lesions outside the meninges in the absence of a pre-existing meningitis. There is considerable evidence, however, that such infections do occasionally occur. The meningococcus has now been reported several times as occurring in the blood in cases in which there was no evidence whatever of a pre-existing or accompanying meningitis.

The earliest case of primary meningococcus septicemia to be reported is that of Salomon,[10] which appeared in 1902. A woman, 32 years old, was seized with pain and swellings in her hands, elbows, and knees. These symptoms were followed by chills, fever, and a profuse eruption resembling erythema exudativum. Blood-cultures on agar and in broth yielded the meningococcus. For two months these symptoms continued, the clinical picture being that of a severe sepsis. The patient then developed meningitis, and the cloudy fluid removed by lumbar puncture showed the meningococcus. The patient finally recovered. As there were no symptoms of meningitis during the first two months, it is reasonable to conclude with Salomon that the septicemia preceded the meningitis. The bacteriological notes in this case are very brief. The statement is made that the organism isolated "agreed in all its bacteriological properties with those of the meningococcus," but no cultural or serum reactions are reported.

Andrewes'[11] case, reported in 1906, was that of a physician 50 years old who suddenly developed a hemorrhagic purpura and died a few days later. There were no symptoms of meningitis. Blood-cultures on agar and in broth gave a pure growth of meningococcus. Smears from the blood showed intracellular diplococci in the leukocytes. At the autopsy no meningitis could be found. The organism fermented glucose and maltose and was slightly pathogenic for guinea-pigs.

Digitized by Google

In 1908 Liebermeister[12] reported the following case: A laborer, aged 59, was admitted to the hospital complaining of pain and stiffness in both shoulders. His symptoms and fever were of the septic type. There was a roseola resembling that of typhoid. There were no signs of meningitis. Several blood-cultures were taken, and all of them yielded the meningococcus. The spinal fluid, however, was normal. After several months' illness the patient recovered without ever having had any symptoms of meningitis. The diplococcus isolated from this case gave the characteristic cultural reactions and was agglutinated by a 1 to 300 dilution of antimeningococcus serum. The patient's serum agglutinated his own organism at a dilution of 1 to 50.

Bovaird[13] has recently reported an interesting case of meningococcus septicemia, occurring in a girl 15 years of age. She was taken suddenly with nausea, vomiting and headache. A few hours later a profuse eruption of irregular purpuric spots appeared over her entire body, and she became stuporous. There was some stiffness of the neck, a positive Kernig, and general hyperesthesia, but the spinal fluid was persistently sterile and free from purulent exudate. Blood cultures gave the meningococcus. The patient developed a severe iridocyclitis, but eventually recovered after receiving several injections of Flexner's antimeningitis serum.

Netter's[14] case of meningococcus septicemia, reported in 1909, rests on rather inconclusive evidence, but it is at least suspicious. A woman was admitted to the hospital complaining of diarrhea, fever and general malaise. Physical examination showed only a mild bronchitis and some epigastric sensitiveness. There were no signs of meningitis. Spinal fluid was normal. No blood-culture was taken, but the patient's serum agglutinated two strains of meningococcus at a dilution of 1

Digitized by Google

to 400. The patient's sister had cerebrospinal fever at the time. The diagnosis of meningococcus septicemia was made. She was treated with antimeningitis serum and made a rapid recovery.

Five cases, then, of meningococcus septicemia not associated with meningitis have been reported. In four of these the diagnosis rests on more or less conclusive evidence. Of the five cases only one came to autopsy, that of Andrewes. In this case no focus of infection was recognizable.

In these five cases of primary meningococcus septicemia, no mention is made of any cardiac symptoms suggesting an endocarditis. We have been able, however, to find reports of four cases of meningococcus endocarditis in the literature.

Westenhöffer[15] in his pathological study of twenty-nine cases of epidemic meningitis reported two instances of acute verrucous endocarditis associated with this disease. The first patient, a child 1 year old, had been ill three weeks with epidemic meningitis. At the autopsy there was a suppurative meningitis, bronchopneumonia, acute pharyngitis, and acute rhinitis. On one of the mitral leaflets, small grayish vegetations, the size of peas, occurred.

The second case was that of a woman 21 years old. She was ill only five days. The autopsy showed suppurative meningitis, acute pharyngitis, and acute rhinitis. In the heart both mitral leaflets were the seats of fresh gray vegetations.

No bacteriological report is given in either case. Though the evidence is in favor of a meningococcal origin, it is unfortunate that smears and cultures were not taken from the vegetations.

Weichselbaum and Ghon[16] report the following case: A little girl 9 years old had typical cerebrospinal meningitis. She died after the fifth week, and the autopsy showed meningitis, otitis media, lobar pneumonia, pericarditis, and acute vegeta-

Digitized by Google

tive mitral endocarditis. The meningococcus was recovered from the vegetation. Cultures from the purulent exudate on the brain were sterile, but smears showed Gram-negative diplococci in the leukocytes.

The case of Warfield and Walker[17] is a particularly interesting one. A negro, 32 years of age, was admitted to the hospital in a delirious condition. For two weeks preceding his admission he had been suffering with headache and cough and later with chills, fever, and delirium. On examination there was herpes, a coated and tremulous tongue, a loud systolic murmur at the apex of the heart, and a temperature of 103 F. Leukocytes 11,000. Patient continued to have chills and to run a septic temperature. At no time were there any symptoms of meningitis. Blood-cultures showed a pure growth of meningococcus. Patient became gradually weaker and finally died one month after admission.

At the autopsy there were acute ulcerative endocarditis of the mitral valve, mitral stenosis, anemic infarcts in spleen and kidneys, and chronic diffuse nephritis. Cultures from the vegetation gave a pure growth of meningococcus. Cultures from the splenic infarct contained streptococcus.

The following is a summary of our case:

REPORT OF CASE.

Patient.—A stage carpenter, aged 31, was admitted to the Second Medical Division of the Presbyterian Hospital, June 5, 1910, complaining of headache, pain in left arm and chest, lassitude, and fever. Family history was negative; personal history negative, except for immoderate use of alcohol. Patient gave history of two attacks of rheumatism, the first one fifteen years ago, the second, twelve years ago. He was confined to bed several months during both attacks. He had gonorrhea five years ago. No history of lues.

Present Illness.—Two weeks before admission patient had a sore throat, felt feverish, and noticed some pain and tenderness in right wrist and elbow. Two days later he began to have severe frontal headaches, which continued up to time of admission. He had vomited a number of times and had some diarrhea.

Digitized by Google

In spite of these symptoms, patient continued to work until four days before admission. At that time he began to have a dull pain across the whole anterior chest, which was not increased by the cough that now developed.

Physical Examination.—The patient is a well-nourished man, mentally clear, good color, but much prostrated. Ear-drums normal. Left pupil larger than right, but both react normally. Tonsils moderately enlarged and congested, but without exudate. Neck not stiff. No enlargement of heart made out. Regular action, 100 per minute. Presystolic and systolic murmurs can be heard at the apex. Lungs normal. Abdomen soft. Spleen not felt. No petechiæ, no Kernig, no Babinski. Knee-jerks sluggish. Right ankle somewhat swollen and painful on motion. On the third finger of the right hand the metacarpophalangeal and first interphalangeal joints are swollen, red, and quite tender. Considerable coarse tremor of hands. Temperature 102.5. Pulse 100. Respiration 32. Clinical diagnosis: Rheumatic fever and endocarditis.

Course of Disease.—June 8: The patient's temperature rose to 104.5 and has maintained a level of 102-104.5. Marked tremor of hands has developed. Patient is quite irrational. Symptoms and physical signs otherwise the same. Leukocytes 15,000; 86 per cent. polynuclear leukocytes. The picture is that of an extreme toxemia. The blood-culture taken on the day after admission has been reported sterile. Widal reaction negative.

June 9: Patient delirius with fairly marked subsultus. Leukocytes 12,000 with 90 per cent. polynuclear leukocytes. No petechiæ. No signs of meningitis.

June 12: Temperature has continued on a level of 103-104. Pulse and respiration have slowly increased, and are now respectively 120-124 and 28-32. Clinically patient has presented a picture of typhoid, except for the absence of rose spots and enlarged spleen. He lies semi-delirious the whole time, having considerable twitching and subsultus. Movements are involuntary, but patient takes fluid greedily. Circulation has kept up well. Blood-culture taken on June 9 gave a pure growth of a Gram-negative diplococcus, which was reported as probably meningoccocus. On the basis of that report patient was given 15 c.c. of Flexner's antimeningitis serum subcutaneously without effect. Patient has had no signs of meningitis.

June 14: Patient gradually failing. Temperature, pulse, and respiration are all rising. The blood-culture on June 12 shows same organism found in previous culture. To-day patient received introvenously 15 c.c. of Flexner's serum. Lumbar puncture performed three days ago showed normal fluid. There are now for the first time a few petechial spots, size of pin-heads, just beneath left clavicle.

June 15: Temperature rose to-day to 106. Delirium changed to coma. Some stiffness of legs and neck, thought not to be that of meningitis. Patient died to-night, circulation having steadily failed despite stimulation.

Necropsy.—Performed June 16, sixteen hours after death. Only the most interesting features will be referred to. The body is that of a fairly well-

Digitized by Google

nourished young man, 176 cm. in length. Post-mortem rigidity is present. There is livor mortis in the dependent parts. On opening the abdomen, the liver is found bound to the diaphragm by firm fibrous adhesions. With this exception the abdominal cavity is negative.

There are old fibrous adhesions in both pleural cavities. The lungs are voluminous and heavy. From their cut surfaces, which are dark red, there oozes considerable blood-tinged frothy fluid.

The pericardial sac has been partially obliterated by fibrous adhesions. The heart, with pericardium attached, weighs 670 gm. and is considerably enlarged. The pericardium is peeled off with difficulty, exposing a rough, ragged surface. The right side of the heart contains a post-mortem blood-clot. The tricuspid valve measures 12.5 cm. in circumference, the pulmonary valve, 8.5 cm. The leaflets of both valves are normal. There is some hypertrophy of the right ventricle.

The mitral valve measures 8.5 cm. in circumference. The two curtains are thickened and fused together so as to form a thick ring. On the auricular surface of the anterior curtain there is a soft cauliflower vegetation, 1.5 cm. in diameter. The base of the vegetation is firmly adherent to the valve leaflet. The aortic leaflets are thickened and pouched. The free borders of the segments are retracted. The left ventricle is considerably enlarged. The papillary muscles are hypertrophied. The musculi pectinati are somewhat flattened. The left ventricular wall measures about 2 cm. in thickeness, and has a soft flabby consistence. The musculature is reddish-brown and homogeneous. The coronary arteries are clear.

The spleen is large and soft, weight, 590 gm. The capsule is smooth. The cut surface is dark purplish red, and has a velvety appearance. Considerable pulp comes away with the knife. The markings are indistinct. Along the anterior border there is a sharply defined pinkish-white area, which on section corresponds to the base of an irregular wedge, firm in consistence, and slightly elevated above the surrounding tissue.

The liver is large and rather soft and pliable. Weight, 2,050 gm. The cut surface is pinkish yellow and opaque. Gall-bladder and bile ducts normal.

The pancreas weighs 200 gm. with duodenum attached, and appears normal.

The right kidney weighs 190 gm. The capsule is somewhat adherent. The surface of the kidney is finely granular. The cut surface is cloudy and swollen, the cortex measuring 10 mm. in thickness in some places. At the upper pole, there is a small pale yellow area surrounded by a narrow zone of red. Section through this area exposes a firm wedge-shaped mass of yellow tissue, surrounded by a dark red zone. The pelvis of the kidney is dilated and contains a large rough stone, which sends off prejections into the calyces. The pelvic mucosa is injected, roughened, and covered with mucus. The right ureter is normal.

Digitized by Google

The left kidney weighs 240 gm. It is finely granular and cloudy like the right. No infarcts occur. Left pelvis and ureter normal.

The suprarenals are normal.

The bladder and prostate are normal.

Nothing of interest is found in the gastro-intestinal tract. The aorta shows no changes. The larynx and trachea are normal.

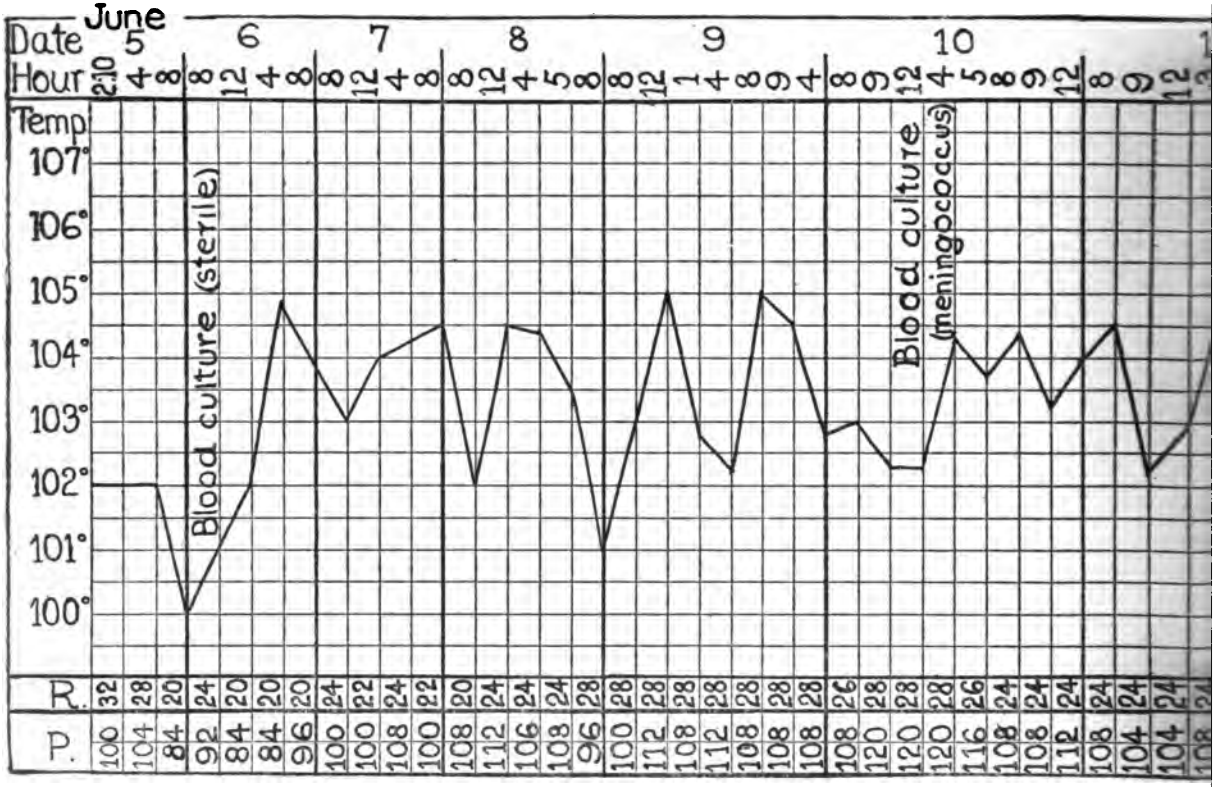


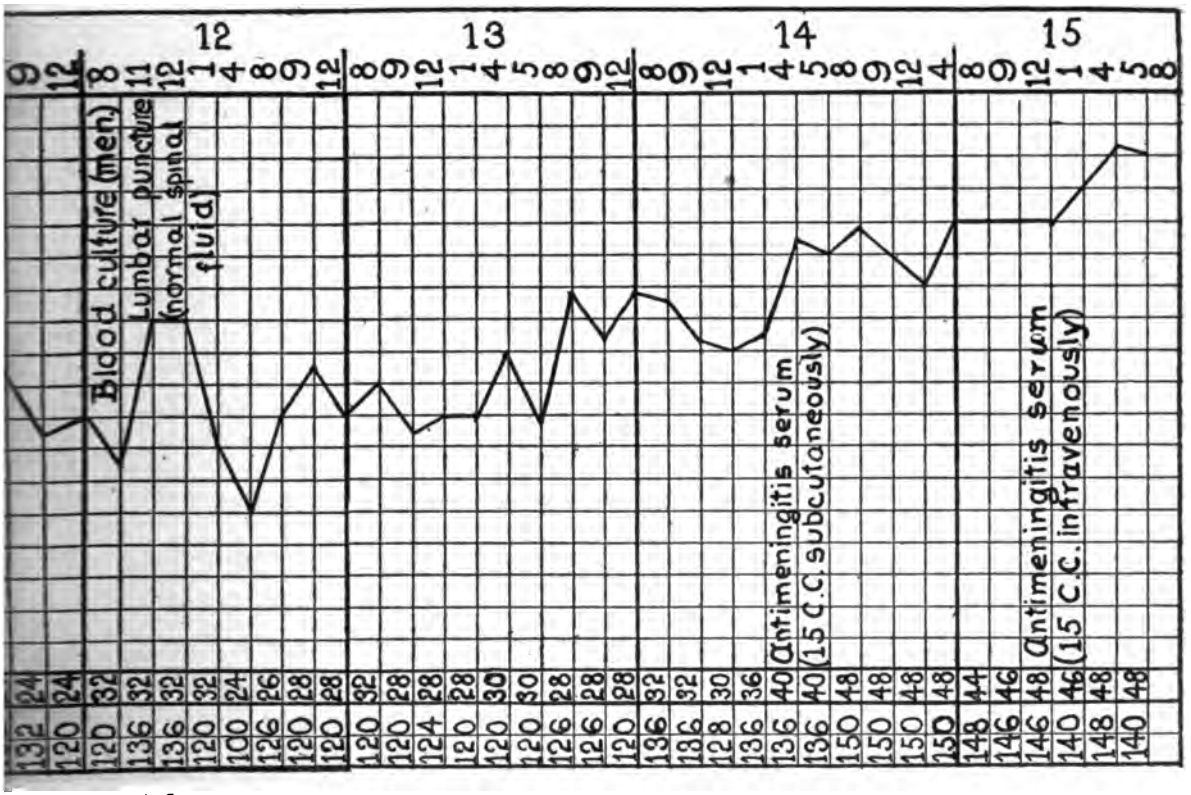
Chart of temperat

The brain weighs 1,450 gm. The dura mater is normal. The cortex is edematous, but translucent. The sulci contain clear serum. The base of the brain is free from exudate. The ventricles are normal. Frontal sections through entire brain show nothing of interest.

Digitized by Google

Microscopical sections from the organs showed the following: Brain: Sections through the various parts of the cortex, as well as the pons and medulla, show a normal pia-arachnoid. Here and there a few lymphoid and plasma cells occur, but nothing suggestive of an exudate can be made out.

Vegetation on Mitral Valve: The vegetation is composed chiefly of fibrin, which in many places has undergone hyaline necrosis. Toward the periphery,



1 case reported.

the vegetation contains a large number of polynuclear leukocytes, many of them partially disintegrated.

Kidney: The epithelium of the convoluted tubules is cloudy and granular. At one point in the cortex the tubules and glomeruli have undergone a hyaline

Digitized by Google

necrosis. Around this necrotic area, the veins and capillaries are intensely congested.

Spleen: The sinuses are filled with red blood-cells. There is a large area of coagulation necrosis, throughout which a net-work of fibrin is seen. Just outside the necrotic area, there is a hemorrhagic zone. In several of the larger veins passing through the necrotic focus, fresh mural thrombi occur, some of them occupying half or more of the vessel's lumen.

The liver is cloudy.

Pancreas, suprarenal, lungs and prostate normal.

Heart muscle: There is a slight increase of the interstitial tissue.

Anatomical Diagnosis.—Acute vegetative mitral endocarditis, chronic mitral and aortic endocarditis, mitral stenosis, hypertrophy and dilatation of heart, chronic fibrous pericarditis, chronic interstitial myocarditis, chronic fibrous pleuritis, congestion and edema of the lungs, acute splenic tumor, chronic interstitial nephritis, nephrolithiasis, anemic infarcts in spleen and right kidney, cloudy swelling of viscera.

Bacteriological Examination of the Various Organs.—1. Smears from the vegetation on the mitral valve show red blood-cells, fibrin, and leukocytes. In some of the leukocytes, one to a half dozen pair of Gram-negative diplococci are found. These organisms are biscuit-shaped and show various stages of dissolution. Morphologically, they resemble in every way the diplococcus found in the blood-cultures. A culture taken from the surface of the vegetation shows one colony of *B. coli communis.*

2. Smears from the serous fluid beneath the pia mater show a few endothelial cells. No pus cells or diplococci can be found. Cultures from pia mater give streptococci and colon bacilli.

3. Cultures from liver, spleen, and heart's blood show many colonies of *Bacillus coli communis* and a few colonies of streptococcus.

4. Smears and cultures from the prostate gland show no gonococci.

In order to establish firmly the diagnosis of meningococcus endocarditis it has been necessary to prove two premises: first, that the organism isolated from the patient's blood was a genuine meningococcus; second, that this organism was instrumental in producing the vegetations on the mitral valve.

Bacteriological Study of the Diplococcus

1. *Morphology.*—The organism isolated from the patient's blood is a small biscuit-shaped diplococcus, which does not retain the Gram stain. Morphologically, it resembles the gonococ-

Digitized by Google

cus. The diplococci vary considerably in size and many involution forms occur.

2. *Cultural Reactions.*—Subcultures taken from the original broth flasks showed the following:

On ascitic glucose agar, after twenty-four hours, there appeared a diffuse, grayish, translucent mucoid growth. When some of the growth was removed with a platinum wire, it was seen to have a distinctly viscid quality.

Subcultures in broth, plain agar, blood agar, glucose agar, litmus milk, and Loeffler's blood-serum all remained sterile. By making generous transfers, however, from the ascitic glucose agar culture, growths were obtained on all the serum media, and two weeks later the organism was successfully cultivated on plain and on glucose agar.

TABLE 1.—AGGLUTINATION TEST.

Organism	1-10	1-25	1-50	1-100	1-250	1-500	1-1000	1-2500	1-5000	1-10000	1-15000	Salt Solution Control
Diplococcus, J. S.	++	++	++	++	+	+	—	—	—	—	—	—
Meningococcus "Duval"	+	+	+	+	+	+	+	+	+	+	+	—
Meningococcus 250.....	+	+	+	+	+	+	+	+	+	+	+	—

3. *Fermentation Tests.*—The organism ferments glucose and maltose, but not lactose or saccharose.

4. *Pathogenicity.*—A guinea-pig was injected peritoneally with one-fourth of a twenty-four-hour growth of the organism on glucose agar. He appeared sick on the following day, but completely recovered. This test of the organism's pathogenicity was not carried out until two weeks after its first cultivation on culture media.

Digitized by Google

5. *Agglutination and Absorption Tests.*—An emulsion of the organism in normal salt solution was prepared from a twenty-four-hour culture on glucose agar. The proportion was 4 mg. of the growth to 1 c.c. of salt solution. Two stock strains of meningococcus were used for controls. The three organisms were tested with the serum from a rabbit highly immunized against the meningococcus. Equal parts of the emulsion and of the variously diluted serum were mixed in small test-tubes and allowed to stand in the incubator at 37 C. for two hours. They were then placed in the ice-box for twenty-four hours. In the positive reactions a flocculent sediment was covered by clear supernatant fluid. In the negative reactions the emulsion remained homogeneous and opalescent. Table 1 shows the results obtained.

Diplococcus J. S., the organism under consideration, was agglutinated by a 1 to 100 dilution of the serum. The first control strain of meningococcus was agglutinated by a 1 to 500 dilution of the serum; the second control, the homologous strain, was agglutinated by a much higher dilution, 1 to 15,000.

In the absorption tests a 1 to 5 dilution of the serum was first mixed with 1 c.c. of an emulsion of the organism, and the mixture incubated at 37 C. for two hours. Then, after thorough centrifugalization, the clear serum was decanted off, and various dilutions of it were tested with the organisms as in the original agglutination tests. In Table 2 the results are seen.

TABLE 2.—ABSORPTION OF MENINGOCOCCUS IMMUNE SERUM.

Organism.	Agglutinative Titer with Unabsorbed Serum.	Agglutinative Titer after Absorption with Diplococcus J. S.	Percentage of Agglutinins Lost by Absorption.	Agglutinative Titer after Absorption with Meningococcus 250.	Percentage of Agglutinins Lost by Absorption.
Diplococcus, J. S.....	1-100	1-25	75	1-25	75
Meningococcus, 250...	1-15000	1-5000	66.6	1-10000	33.3

Digitized by Google

The table shows that after absorption of the serum for two hours with diplococcus J. S., the agglutinating power of the serum was considerably reduced for both organisms. In other words, diplococcus J. S. had the power to absorb specific meningococcus agglutinins. Similar reductions in the agglutinative titer of the serum were observed after absorption with its homologous strain, "meningococcus 250."

6. *Deviation of Complement.*—In addition to the agglutination and absorption tests, we have also tried the deviation of complement test. The hemolytic system devised by Noguchi[18] was employed. The antigen was prepared as follows: a twenty-four-hour growth of the organism was washed from the surface of a glucose agar slant with 1 c.c. of normal salt solution. The emulsion was well shaken, covered with toluol, and allowed to autolyze over night in the incubator at 37 C. The toluol was then carefully removed, the emulsion centrifugalized, and the clear supernatant fluid pipetted off. For amboceptor we used antimeningococcus horse serum, which was kindly furnished us by Dr. Lamar of the Rockefeller Institute.

There was complete inhibition of hemolysis when 0.01 c.c. of antigen from diplococcus J. S., and 0.05 c.c. of the antimeningococcus serum, were used. With the control strain, inhibition occurred with a slightly smaller quantity of amboceptor, namely 0.02 c.c. These tests were of course controlled with normal horse-serum.

The organism showed all the morphological and cultural characteristics of the meningococcus. It was agglutinated by a 1-to-100 dilution of antimeningococcus serum; finally, it possessed the power of absorbing specific meningococcus agglutinins, and of binding complement with specific antimeningococcus amboceptor. We feel justified therefore in concluding that the organism was a genuine meningococcus.

Digitized by Google

Bacteriological Examination of the Vegetation.

In order to show that the vegetations on the mitral valve were caused by the meningococcus, we studied the smears and culture taken at the autopsy, and in addition have cut sections of the vegetation and stained them for bacteria. The smears showed the characteristic Gram-negative diplococci in the leukocytes. Only one culture was taken from the vegetation, and that showed a single colony of *B. coli communis.*

Examination of sections through the vegetation reveals many polynuclear leukocytes in a partially necrotic network of fibrin. In many of the leukocytes one to a half dozen pair of Gram-negative biscuit-shaped diplococci can be seen. No streptococci can be found in any of the sections of the vegetation.

After having found streptococci in the cultures from the liver, spleen, and heart's blood, it occurred to us that perhaps after all we had been dealing primarily with a streptococcus endocarditis, and that the meningococcus was a secondary invader. A careful study, however, of the smears and sections taken from the vegetations has convinced us that the reverse is true. It has been our experience that in streptococcus endocarditis, no difficulty is found in demonstrating streptococci in and on the vegetation. In the present case, we were unable to demonstrate streptococci in the lesion, but were able to find large numbers of Gram-negative diplococci in the cellular elements of the vegetation.

The streptococcus and colon bacillus were probably both terminal or post-mortem invaders. Neither of these organisms was found in any of the blood-cultures taken. The eighteen hours which elapsed between the death of the patient and the autopsy gave opportunity for extensive multiplication of the

Digitized by Google

colon bacillus in the blood. Its colonies occurred in large numbers in all the cultures, excepting the one from the vegetation, which contained only one colony of colon bacillus.

The absence of meningococci from all the cultures taken at autopsy may be explained in several ways. The low vitality of the meningococcus, and the fact of its being usually intracellular make it a difficult organism to cultivate under the most favorable circumstances. On several occasions we have seen spinal fluids which contained meningococci in the leukocytes, but from which cultures were persistently sterile. Moreover Flexner[19] found that in the case of guinea-pigs, killed by intraperitoneal injections of meningococci, if the autopsies were delayed until partial decomposition of the body had set in, or if the dead pigs had been kept for many hours in the refrigerator, the chances of successful cultivation of the meningococcus were greatly reduced. He explains this in the first instance as probably due to the combined action of inflammatory exudate and the products of decomposition; in the second instance, to the low temperature. The fact that in our case the cadaver had been in the mortuary sixteen hours may have been responsible for the negative results obtained.

The second premise may therefore be accepted as proved, namely, that the vegetations were produced by the meningococcus.

Discussion.

A critical review of this case and of the four cases reported from the literature reveals nothing definitely characteristic in either the clinical signs or the pathological anatomy of meningococcus endocarditis. Three of the cases were associated with epidemic cerebrospinal meningitis. The other two had no such association. Without bacteriological data, the two cases not

Digitized by Google

accompanied by meningitis might readily have been treated as cases of malignant endocarditis, and even the autopsy would have failed to show the real character of the infection. The cardiac symptoms, the septic temperature, the petechiæ, the prostration, delirium and coma are all seen in streptococcus or pneumococcus endocarditis; the cauliflower vegetations, the infarcts in the kidney and spleen differ in no way from those commonly observed in acute endocarditis of other origin.

It is interesting to note that in our case the first symptom was a sore throat. In the case of Warfield and Walker[17] the disease was ushered in with a cough and yellowish expectoration. According to Osler,[20] all cases of endocarditis may be regarded as secondary to an existing infection. The frequent association of tonsillitis with rheumatism and endocarditis has led many to the belief that the tonsil is the most common portal of entry for the infecting agent in these diseases. In our case the pre-existence of a sore throat and the absence of any other focus of infection would give some ground for suspecting the tonsils, especially when on examination they were enlarged and congested. Unfortunately they were not examined at the autopsy. This suspicion is strengthened somewhat by recalling the fact that the meningococcus is sometimes found in healthy mouths, and is constantly present in the nasopharynx during an attack of epidemic meningitis. Westenhöffer makes the statement that every case of epidemic meningitis is first a case of meningococcus pharyngitis.[21] In twenty-nine autopsies on cases of epidemic meningitis he was able to demonstrate an acute pharyngitis in all of them. The nasopharynx was filled with mucus and the pharyngeal tonsil was invariably swollen and congested. Meyer[22] made a clinical study of thirty-two cases of this disease early in its course, and in twenty-four of them found a well-marked inflammation of the nasopharynx.

Digitized by Google

He was also able to demonstrate inflammation of the pharyngeal tonsil in a majority of cases. Meyer reports one particularly interesting case. The meningococcus was isolated from the secretion in the throat of a patient suffering with angina tonsillaris. On the following day the patient developed a typical meningitis. Von Lingelsheim[23] made an exhaustive bacteriological study of nasal and pharyngeal secretions in epidemic meningitis. He was able to isolate the meningococcus from the nasopharynx of 93.8 per cent. of all cases of meningitis examined. The same organism was found in 15 per cent. of the throats of nurses and attendants. Westenhöffer raises the question whether the nasopharyngeal inflammation could be secondary to the meningitis, and concludes that its appearance so early in the disease, sometimes even preceding it, and the existence of meningococcus "carriers" speak against such a possibility. Kutscher[24] reviews the literature on this subject and concludes that the constant association of pharyngitis with meningitis, and the frequent finding of the meningococcus in the pharynx and nares in cases of meningitis, as well as in those of healthy people, make it in the highest degree probable that the nasopharynx is the portal of entry for the meningococcus.

Although it is generally accepted that the meningococcus gains access to the system by way of the upper respiratory tract, there is some disagreement as to the course taken by the meningococcus in reaching the brain. The earlier writers, notably Weigert, assumed that the infection reached the brain by direct extension upward through the cribriform plate of the ethmoid bone. The nasopharyngeal inflammation, the close proximity of the meninges, and the distribution of the exudate over the base of the brain were the chief arguments brought forward in support of this theory. Westenhöffer,[15] however,

Digitized by Google

in his pathological study of twenty-nine cases, found the ethmoid cells inflamed in only two cases; and in these the changes were slight and apparently secondary to the accompanying rhinitis. In the remaining twenty-seven cases there was nothing to suggest an infection through the cribriform plate.

The investigations of Meyer, Von Lingelsheim, Westenhöffer and others have shown pretty clearly that infection of the meninges, if it does occur by direct extension upward, is effected by an extension from the nasopharynx through the sphenoid bone rather than by an extension from the nasal cavities through the cribriform plate. The constant inflammatory changes in the pharynx have already been referred to; the anterior portions of the nasal cavities are generally free from inflammation. The meningococcus can usually be recovered from the pharynx; rarely from the nose. Westenhöffer[21] believes that epidemic meningitis follows extension of the inflammation through the sphenoidal sinus, and he has formulated an interesting theory in support of it. He quotes the evidence in favor of the hypophysis being a rudimentary sense organ, and observes that the sella turcica almost completely encloses the hypophysis, forming a bony casement about it similar to that about the internal ear. He then refers to the frequent involvement in meningitis of the other cavities connected with the nose and pharynx, and argues that the meningococcal infection, having once involved the sphenoidal sinus, might readily extend through the thin lamina of bone above it. Thirty-four per cent. of Westenhöffer's cases showed an involvement of the sphenoidal sinus. He also found that in patients who died early in the disease, the meningeal exudate was often confined to the region of the hypophysis. He admits, however, that the same type of perihypophysial inflammation may be demonstrated in otogenous, as well as in tuberculous meningitis.

Digitized by Google

Flexner[25] showed that meningococci, when introduced into a low level of the spinal canal of monkeys, distribute themselves in a few hours through the meninges and produce an exudate which accumulates chiefly in the lower spinal meninges and the meninges of the base of the brain. This constant distribution in monkeys of the exudate over the base of the brain led Flexner to "doubt the validity of the reasoning which would ascribe this localization of the inflammation in man to the entrance into the meninges of the infective agent directly through the nasal membrane."

Westenhöffer[15] could find no definite evidence of an infection along the nerve-sheaths, or by way of the lymph-spaces about the carotid arteries. In the few cases in which mild inflammatory changes were encountered, the process was apparently an extension from above downward. He did note a constant enlargement of the cervical lymph-glands with hyperplasia of the chyme centers and infiltration with lymphoid cells.

The occurrence of cases such as the one we have here reported permit a consideration of the hematogenous theory of infection in epidemic meningitis.

Esler and Huntoon,[26] in an exhaustive study of epidemic meningitis, discuss the mode of infection at some length, and summarize the evidence in favor of a hematogenous origin as follows:

> The early appearance of the meningococcus in the blood in a considerable number of cases, the appearance of general sepsis suggested by some patients early in the disease, the lesions in parts far removed from the central nervous system found at the autopsy of individuals who succumbed to the disease within twenty-four hours of its inception, and finally the appearance of characteristic lesions in the eye synchronously with manifestations referable to the central nervous system, all point toward an early generalization of the meningococci, but are not competent to prove that such a general infection actually antedated the meningeal involvement.

Digitized by Google

The writers just quoted also emphasize the sudden onset of epidemic meningitis, contrasting it in this respect with other forms of meningitis in which a direct infection of the crebral meninges is reasonably certain, for example, in otogenic or traumatic forms of meningitis. In the latter the onset is usually gradual, beginning apparently as a more or less limited process and extending by degrees over the entire brain. This fact, they reason, is strongly suggestive of a hematogenous infection.

The problem does not lend itself readily to solution by experimental methods. The monkey is the only other animal in which lesions similar to those occurring in man have been produced, but there is a great difference in the degree of their susceptibility. Flexner,[25] studying epidemic meningitis in monkeys, found evidence of extension of the meningeal inflammation into the membranes covering the olfactory lobes and along the dura mater into the ethmoid plate and nasal mucosa. Smears from the nasal mucous membrane showed polynuclear leukocytes containing intracellular diplococci similar in all respects to meningococci. He did not succeed, however, in cultivating the meningococcus from the nose.

Bettencourt and Franca[27] attempted without success to infect monkeys by rubbing the nasal mucous membrane with cotton soaked in a culture of the meningococcus. Negative results have also been obtained when meningococci were injected intravenously into monkeys. It is not surprising that these efforts to infect monkeys outside of the spinal canal have been fruitless. Flexner[25] concluded from his experiments that the quantity of living culture required to cause marked symptoms or death from meningitis in monkeys is enormous if compared with the number of diplococci which probably suffice to produce infection in human beings. If the production of meningitis in

Digitized by Google

monkeys by direct intraspinal injection of meningococci is fraught with such difficulties, it would naturally follow that infection through the blood or lymph, fluids much richer in immune bodies than the spinal fluid, would be still more difficult, or even impossible.

Esler and Huntoon[26] report some interesting and significant experiments which they conducted with a *Streptococcus mucosus*. This organism when injected into the circulating blood of a rabbit, caused some elevation of temperature and loss of weight, but no other symptoms until three days had elapsed. On the fourth day typical symptoms of meningitis developed very suddenly, and the animal died after an illness of only four hours. At the autopsy the brain and cord showed a purulent cerebrospinal meningitis, with a distribution of lesions identical with that found in the epidemic form of meningitis in man. The *Streptococcus mucosus* was recovered from the meningeal exudate. Similar lesions were produced in another rabbit by injecting a pure culture of the same organism in the region of the tonsil. The authors concluded that the organism in question had a special predilection for the meninges of rabbits, analogous to that which the meningococcus shows for the meninges of man. They reasoned that the hematogenous origin of the one spoke strongly for a similar origin in the other.

The evidence therefore at the present time is in favor of a hematogenous mode of infection in epidemic meningitis. It is, of course, possible that infection may occur by either of the routes which have been discussed. Certainly streptococcus, pneumococcus, and staphylococcus meningitis may be either hematogenous or subsequent to direct extension of the infection inward.

Digitized by Google

The cases of meningococcus endocarditis which we have reported or reviewed have brought out the following interesting facts:

1. The meningococcus, in spite of its affinity for the meninges, may at times become lodged on the endocardium, with the production of an acute vegetative endocarditis. In this respect it resembles most of the other pathogenic bacteria, which, while showing a predilection for some particular organ or tissue, may occasionally produce serious lesions in other parts of the body.

2. The symptoms and pathological anatomy of meningococcus endocarditis correspond to those which characterize malignant endocarditis of streptococcus or pneumococcus origin.

3. Meningococcus endocarditis may or may not be associated with cerebrospinal meningitis.

4. The portal of entry for the organism in meningococcus endocarditis is probably the upper respiratory treat. It is particularly interesting to note that the avenue of infection is the same as that generally accepted as the portal of entry for streptococcus endocarditis on the one hand, and for meningococcus meningitis on the other.

5. The occurrence of primary meningococcus endocarditis with meningococcus septicemia furnishes evidence in favor of a hematogenous mode of infection in epidemic cerebrospinal meningitis.

Digitized by Google

We wish to thank Dr. Kinnicutt for the privilege of using the clinical notes of this case.

We are also much indebted to Dr. Frank M. Huntoon and to Dr. Richard V. Lamar for their kind suggestions and help in the serological tests.

41 E. Seventieth Street.

[1] Gwyn: Bull. Johns Hopkins Hosp., 1899, X, 112.

[2] Cochez and Lemaire: Arch. gén. de méd., 1901, I, 573, 667.

[3] Jakobitz: München. med. Wchnschr., 1905, LII, 2178.

[4] Martini and Rohde: Berl. klin. Wchnschr., 1905, XLII, 997.

[5] Lenhartz: Deutsch. Arch. f. klin. Med., 1905, LXXXIV, 81.

[6] Marcovitch: Wien. klin. Wchnschr., 1906, XIX, 1312.

[7] Robinson: Am. Jour. Med. Sc., 1906, CXXXI, 603.

[8] Duval: Jour. Med. Research, 1908, XIX, 258.

[9] Elser: Jour. Med. Research, 1905, XIV, 89.

[10] Salomon: Berl. klin. Wchnschr., 1902, XXXIX, 1045.

[11] Andrewes: Lancet, London, 1906, LXXXIV, 1172.

[12] Liebermeister: München. med. Wchnschr., 1908, LV, 1978.

[13] Bovaird, David: Meningococcus Septicemia with Sterile Cerebrospinal Fluid, Iridocyclitis Flexner's Serum Recovery, The Archives Int. Med., 1909, III, 267.

[14] Netter: Bull. de l'Acad. de Med., Paris, 1909, LXII, 108.

[15] Westenhöffer: Klin. Jahrb., 1906, XV, 657.

[16] Weichselbaum and Ghon: Wien. klin. Wchnschr., 1905, XVIII, 625.

[17] Warfield and Walker: Bull. Ayer Clin. Lab., 1903-'06, I-III, 81.

[18] Noguchi. Jour. Exper. Med., 1909, XI, 392.

[19] Flexner: Jour. Exper. Med., 1907, IX, 105.

[20] Osler: Modern Medicine, 1908, IV, 133.

[21] Westenhöffer: Berl. klin. Wchnschr., 1905, XLII, 737.

[22] Meyer: Klin. Jahrb., 1906, XV, 637.

[23] Von Lingelsheim: Klin. Jahrb., 1906, XV, 373.

[24] Kutscher: In Kolle und Wassermann's Pathogene Microorganismen, 1907, Erster Ergänzungsbd., p. 481.

[25] Flexner: Jour. Exper. Med., 1907, IX, 142.

[26] Elser and Huntoon: Jour. Med. Research, 1909, XX, 373.

[27] Bettencourt and Franca: Ztschr. f. Hyg. u. Infektionskrankh., 1904, XLVI, 463.

Digitized by Google

Digitized by Google

V.

ERYTHRAEMIA.

By Francis P. Kinnicutt, Visiting Physician.

Synonyms: Spleno-Megalic Polycythaemia
Myelopathic Polycythaemia
Erythrocytosis Megalo-Splenica (Senator)
Polycythaemia with Chronic Cyanosis
Vaquez' Disease.

The definition of the disease possibly most in harmony with present opinion is that of F. Parkes Weber—"Erythraemia, a disease or morbid condition characterized by well-marked, persistent and absolute polycythæmia (increase in the number of red corpuscles) due to an excessive erythroblastic activity of the bone marrow, which appears to be the primary factor in the condition; it is characterized likewise by persistent increase in the viscosity and total volume of the blood, and usually by a cyanotic appearance of the patient and by enlargement of the spleen."

Vaquez, probably, first described the disease in 1892, in the report of a case of a peculiar form of cyanosis accompanied by excessive and persistent polycythæmia; in 1895 he called attention to the presence of splenomegaly and the absence of cardiac lesions in the same case. In 1897, forty cases had been collected from the literature, and since then others have been added to this number.

The symptoms and signs briefly are as follows: Lassitude, loss of strength, migraine, vertigo, feeling of fulness in the

Digitized by Google

head, digestive disturbances, abdominal pain especially in the splenic region, constipation or diarrhœa, hæmorrhage from various mucous membranes and organs, including cerebral hæmorrhage. All of these symptoms may be present in the individual case or they may exist in varied combinations.

The vascular engorgement, redness or cyanosis of the skin, affecting the entire surface of the body and especially conspicuous in the face, ears, neck, hands and feet, and of the mucous membranes accessible to examination, at once attracts attention. The color varies in different patients and in the same patients at different times. Intense blueness giving place to redness and a reversed sequence, under the influence of changed posture, emotional disturbance, changes in temperature, etc., were observed in the case to be related. The spleen is enlarged, in some instances greatly; the liver in a considerable number of cases.

The blood changes are of great interest. The red cells are increased in number, the range being between seven and thirteen million per cubic millimeter, the latter number having been observed in a single case by Koester. Their diameter is said to be slightly increased. A leucocytosis is very constantly present; frequently 20,000 white cells per cubic millimeter; 54,000 have once been recorded (Weistraud). The percentage of polynuclear neutrophiles is usually increased; myelocytes in varied percentages have often been noted. The specific gravity of the blood is occasionally raised but not proportionally to the increase in the number of red cells. The hæmoglobin value may be very high, but the color index is usually under 1.0.

Viscosity.—The viscosity of the blood is increased. Accepting 4.7 as the viscosity of normal human blood (water the unit), Lommel found the viscosity to be over 11.0 in two cases

Digitized by Google

of polycythæmia with splenomegaly, and viscosities between 12.0 and 23.0 have been recorded. In spite of the high degree of viscosity, the blood pressure is not as a rule considerably increased, and the left ventricle has not been found to be markedly hypertrophied.

The coagulability of the blood may be increased or diminished. Observations on a probable increase in the iron and albumin in the blood as well as on either an increased or diminished resistance to hæmolysis of the red cells are too few, up to the present date, to justify definite conclusions.

THE TOTAL BLOOD VOLUME IN ERYTHRAEMIA.—It is probable that the total volume of the blood is always greatly above the normal. In a number of cases of erythræmia in which it has been estimated by Haldane and Lorrain Smith's carbon monoxide method, the total volume has been found to be one and a half to three times the volume normally corresponding to the patient's body weight. In other words, a true plethora exists.

MORBID ANATOMY.—Anatomical examinations have been made in a number of the published cases of erythræmia and in almost every instance evidence of a presumable increased erythroblastic function of the bone marrow has been present, much of the marrow of the shafts of the long bones being converted into red marrow. In a single case reported by Gibson of Edinburgh, similar evidence of an erythroblastic hyperactivity was demonstrated by exploration during life.

Other post-mortem findings have been, chiefly, enlargement of the spleen, sometimes very great, the increase in size being due partly to engorgement with blood, partly to a hyperplasia of the splenic pulp. In many cases the spleen contained thrombotic infarcts. There was enlargement of the liver in a considerable number of cases, due to engorgement. The lymph nodes have rarely been found affected.

Digitized by Google

A CASE OF ERYTHRAEMIA.—The opportunity has been afforded me recently of studying a case of erythræmia in my wards at the Presbyterian Hospital. With the efficient co-operation of Dr. Meakins in the laboratory, we have been able to add a fairly complete clinical investigation of the disease to the comparatively small number which have thus far been recorded. In the present note I shall refer chiefly to the blood changes found and to the results of other laboratory studies.

The general symptoms closely corresponded to those which I have related. A photograph of the patient gives some idea of the cyanosis present and of the size of the spleen. The outline of the spleen was carefully traced on the skin with an aniline dye previous to photographing. The morbid condition has existed for eight or nine years and the patient is still living, though incapacitated for work. Very careful and repeated physical examinations have never revealed any disease of the heart or lungs. The heart is of normal size and there is an entire absence of murmurs. Aside from the great enlargement of the spleen and enlargement of the liver, physical examination has been negative. The urine has never contained more than a faint trace of albumin, which has been more often absent than present; sugar has been absent, and there has been only a trace of indican; occasionally one or two hyaline casts have been observed; the specific gravity has always been within normal limits. The blood pressure (systolic) has never been found to be above 120 mm. Hg.

THE BLOOD.

March 14, 1908. Red cells, 7,424,000; Haemo. 95%. Color Index 0.64.
300 leucocytes counted.

Polymorphonuclears	72.3%
Transitionals	14.
Large mononuclears	2.
Lymphocytes	1.8

Digitized by Google

Basophiles	2.4
Eosinophiles	7.

Blood plates few.
Red cells, polychromatophilia considerable.

March 19, 1908. Red blood cells, 8,264,000.
Leucocytes, 21,400.

Polymorphonuclears	57.8%
Transitionals	18.2
Large mononuclears	1.5
Large lymphocytes	3.3
Small lymphocytes	1.7
Basophiles	10.6
Eosinophiles	4.7
Myelocytes	2.2

Blood plates many and large.
Red cells, pallor considerable; polychrom. marked.
Normoblasts, 8 seen
Megaloblasts, 4 seen

March 29, 1908. Red blood cells, 7,288,000; leucocytes, 26,200; Haemo. 95%.
Color Index, .651.
800 leucocytes counted.

Polymorphonuclears	68.7%
Transitionals	12.5
Large mononuclears	1.2
Lymphocytes	3.7
Basophiles	6.6
Eosinophiles	3.
Myelocytes	6.6

Red cells, pallor marked; polychrom. marked.
Poikilocytosis slight; basophilic granules marked.
Normoblasts, 10 seen
Megaloblasts, 3 seen

April 2, 1908. Red blood cells, 8,717,000; leucocytes, 26,700; Haemo. 90%;
Color Index, .51.
800 leucocytes counted.

Polymorphonuclears	71.6%
Transitionals	4.3
Large mononuclears	4.
Lymphocytes	4.
Basophiles	2.
Eosinophiles	6.
Myelocytes	8.

Red cells, pallor + ; poikilocytosis + ; basophil. gran. +
Normoblasts, 5 seen; Megaloblasts, none.

Digitized by Google

Nov. 14, 1908. Red blood cells, 8,436,000; leucocytes, 20,300; Haemo. 105%; Color Index, 0.64.

1500 leucocytes counted.

Polymorphonuclears	54.7%
Transitionals	13.1
Large mononuclears	.7
Lymphocytes	9.6
Basophiles	5.6
Eosinophiles	.7
Myelocytes	8.6

Red cells, pallor very slight; polychrom., considerable.

Basophil. gran. slight; normoblasts, 21 seen; megaloblasts, 3 seen. Blood plates in moderate numbers.

Size of red blood cells, smallest, .0045 mm.; largest, .0095 mm.; average, .0065 mm.

There is very little variation from the average, nearly all the cells being of the same size, with no poikilocytosis.

Viscosity of the Blood:

Normal with Oswald's Viscosimeter... 8 seconds

In this instance.....22 seconds (i. e., viscosity 2.7 times that of normal blood.)

Specific gravity of whole blood, 1,065 (normal, 1,059).

Specific gravity of plasma, 1,0255 (normal, 1,028.30).

Blood Content: Red cells = 75% (50% N); plasma, = 25% (50% N).

Oxygen Content: 19% at 0° Centrigrade and 760 mm. Hg. pressure.

Serum of blood shows no increase of hæmolytic power. Red cells show no increased susceptibility to hæmolysis. There is no abnormality in agglutinatives.

	Patient.	*Normal.*
Total oxygen capacity	552.3 c.c.	599 c.c.
Oxygen per cent. in blood	19.0	18.5
Total volume of blood	3100.0 gms.	3427. gms.
Body weight	39.8 kilos.	72.2 kilos.
Blood is of body weight	1/12.8	1/21
Grams of blood per 100 gms. body weight	7.8	4.7
Cubic centimeter of oxygen per 100 gms. body weight	1.3 c.c.	0.83 c.c.

X-ray of long bones shows nothing pathological.

SUMMARY IN OUTLINE.—A chronic cyanosis and polycythæmia existing for many years and not associated either with cardiac or pulmonary disease.

Great enlargement of the spleen and enlargement of the liver.

Digitized by Google

Marked morbid changes in the blood, the red cells ranging between 7,288,000 and 8,717,000 per cubic millimeter; the white cells between 20,300 and 26,700 per cubic millimeter; the polynuclear neutrophiles between 54.7 and 72.3%; myelocytes nearly always present and between 2.2 and 8.6%. Red cells showing little variation in size from the normal. Viscosity 2.7 times that of normal blood. Specific gravity of the whole blood, 1,065; normal, 1,059; specific gravity of the plasma, 1,0255; normal, 1,028.30.

Blood content: Red cells equal 75%, normal 50%; plasma equals 25%, normal 50%. Oxygen content, 19% at 0° Centigrade and 760 mm. Hg. pressure. Grams of blood per 100 grams of body weight 7.8; normal, 4.7. Cubic centimeters of oxygen per 100 grams body weight 1.3 c.c., normal 0.83 c.c. Serum of blood shows no increase of hæmolytic power. Red cells show no increased susceptibility to hæmolysis. There is no abnormality in agglutinatives.

Digitized by Google

Digitized by Google

VI.

PURPURA.*

By J. S. Thacher, M.D., Visiting Physician.

Hemorrhagic disease, or the group of conditions manifesting an abnormal tendency to hemorrhage, either free or into the tissues, comprises a large and but loosely related collection of morbid states. We must, therefore, attempt to classify them, to find some natural grouping of these various conditions, and then to dismiss some of the simpler groups and some of those which are but minor features secondary to other well recognized conditions. We shall then be in a better position to study the more interesting and puzzling remainder.

A.—First, there are those due to mechanical conditions, as in heart disease; portal obstruction; conditions of muscular strain, as in epilepsy, paroxysms of coughing and parturition; embolism and thrombosis, and ulcerative conditions. These need not delay us at all.

B.—There are in the next place conditions of distinct disease of the vascular walls, as arteriosclerosis.

C.—Again, conditions of general malnutrition and intoxication, as in old age, poverty, scurvy, pernicious anemia, leukemia, pregnancy, diseases of the liver, chronic alcoholism, various chronic diseases.

Poisoning with iodine, mercury, antipyrin, phenacetin, chloral, copaiba, quinine, belladonna, arsenic, turpentine, ergot, salicylic acid, or snake venom.

*Read before the Practitioners' Society.

(*Reprinted from the Medical Record, April* 15, 1911.)

Digitized by Google

D.—Also infections, especially smallpox, typhus, cerebrospinal meningitis, ulcerative endocarditis, other septicemias, scarlet fever, measles; and, less prominently, typhoid and paratyphoid fevers, gonorrhea, vaccination, pneumonia, and sore throats and mouth infections.

All these we may dismiss with but a few words, first, to recall that mild infections occasionally present an abundant petechial eruption.

I have recently had two cases with such eruptions, fine, bright, fairly profuse, following sore throat, and followed by speedy and complete cure without much assistance. In each case streptococci were abundant in the throat and in one a pure culture of streptococci was obtained from the blood. The treatment was simply local, of the throat. In the case in which we obtained streptococci from the blood, vaccines were prepared, but before they were ready the patient was improving and they were not used.

In another patient an unusual mouth infection was followed by a profuse eruption partly hemorrhagic. The case was one of whoopingcough in a child and moderate doses of antipyrin had been taken. The mouth infection in this instance took the form of an abundant, furry, white pseudomembrane and spread over nearly the whole mucosa of the mouth and fauces. The elements of this growth seemed bacillary, but the mass mycelial. Its appearance was shortly followed by an abundant eruption over various parts of the body, of hemorrhagic macules, and papules, with some bullæ. Recovery was prompt and the child has been since, as she had been before, perfectly healthy. It was not proved, but it seemed probable, that this hemorrhagic eruption of unusual form was due to a toxemia arising from the peculiar mouth infection.

Digitized by Google

On the other hand, a petechial eruption is sometimes the first distinct warning that a patient may be in a very serious condition. It may be the clue leading to the discovery of a virulent septicemia or may indicate the serious type of an endocarditis.

Two minor groups of cases we will also dismiss, because they are infrequent and we know little and understand less concerning them. These are:

E.—Nervous purpura, and

F.—Hematidrosis.

Purpuric eruptions have been reported as following fright in nervous individuals, as occurring in victims of hemiplegia and multiple sclerosis, and at the site of neuralgic pains. Hemorrhagic eruptions occurring at the menstrual periods and those reported as occurring periodically in men should, perhaps, also be classed as nervous purpura.

Having cleared away this miscellaneous assortment of hemorrhagic conditions, we find the field of our subject occupied by two groups which may be separated from one another with confidence that they are distinct conditions.

In one group the hemorrhagic tendency is strikingly hereditary, and as a rule pretty clearly congenital. The clinical picture, moreover, differs from that of the other group in the great prominence of hemorrhages from the various surfaces and in the much less prominence of other symptoms. The blood, also, by certain tests, shows characteristic abnormalities. To this group should be given the exclusive right to the name hemophilia.

There are cases presenting a similar picture without the history of heredity. These may be variants of the same disease and courtesy should, perhaps, allow them the benefit of the doubt and the title, but for safety's sake arguments and conclu-

Digitized by Google

sions regarding hemophilia should at present be based strictly on the cases which are clearly hereditary.

The hemorrhagic diseases of the new born are often spoken of as hemophilia, but they are thought to be of infectious origin and the use of the name hemophilia for them tends to confusion.

The remaining group is larger in the number of cases and more varied in its clinical picture. The clinical features which we find presented in various combinations by this group of cases are chiefly these: Hemorrhagic eruptions, from minute petechiæ to large ecchymoses; the eruptions of erythema multiforme, erythema nodosum, and urticaria; localized edema; symptoms of arthritis; crises of abdominal pain, often with vomiting or diarrhea, sometimes leading to a diagnosis of intestinal obstruction, and to operation; hemorrhages from the alimentary, the respiratory, or the urinary passages; frequently nephritis; rarely endocarditis and pericarditis. This group we may call idiopathic purpura.

It is interesting to note that, while hemorrhage is a frequent and striking symptom in this group of cases and prominent in our conception of this disease, the eruptions include not only hemorrhagic eruptions but the other eruptions just mentioned of erythematous, urticarial, and edematous types. Osler includes all of these under the term exudative erythema, and uses this as the name for the disease, presenting the eruption as the essential part of the picture, and the other features as complications.

These symptoms, occurring in this group which we call "idiopathic purpura," do not, of course, all of them occur in every case. Some cases are very mild and present but one or two of the symptoms. In some the joint symptoms are prominent, in others the visceral symptoms, in others the hemorrhages. Shall

Digitized by Google

we, therefore, subdivide and further classify the idiopathic purpuras? This has been done for us in the following way: The cases in which the symptoms are very slight, with little beyond a petechial eruption are put by themselves under the title purpura simplex. Those in which joint symptoms are prominent are grouped under the name of purpura rheumatica, or better, purpura arthritica; those with visceral symptoms prominent, under the name of purpura abdominalis or Henoch's purpura, and those in which hemorrhage is a prominent feature, under purpura hemorrhagica. For convenience in studying and recording, it may be well to accept this classification, but it should only be done provisionally and with the admission that as yet no definite lines of cleavage appear between these groups. Each group, even little purpura simplex, may at times present any of the features which are made the bases of distinction for the other groups. Into a special group, called purpura fulminans, have been put those few cases which run a very brief and malignant course. They all, at least all typical cases, occur in children, are fatal, and rarely last longer than eighteen to forty-eight hours.

Can we now make any beginning toward an understanding of these conditions?

Anatomical studies have left us as much in the dark as ever in regard to the nature of the disease or diseases.

At autopsy lesions are often found, but they fail to throw light on the essential nature of the malady. Hemorrhages into the internal organs are frequently seen. The submucosa of the stomach and intestines is a favorite site for these hemorrhages. Necrotic foci have also been found in the walls of the stomach and intestines as well as in the skin. Nephritis is not uncommon, with marked glomerular changes and much epithelial de-

Digitized by Google

generation. Endocarditis and pericarditis are occasionally found, and the spleen is sometimes enlarged.

The majority of gross and microscopical investigations have failed to find any alteration in the blood-vessels. Even the fragility of the capillaries seems not to be increased in hemophilics. This appears from careful observations made by Addis, who applied cups to hemophilic cases, using a definite negative pressure determined with a manometer, and comparing the results with those obtained on normal cases. He found that he caused extravasation no more easily in the hemophilic cases than in the normal.

Suggestions of a bacterial or of a toxic causation for these conditions naturally occur to us. In the earlier days of imperfect methods there were numerous reports of bacterial findings in cases presenting the picture of this disease, but of late years the findings of competent investigators, with more perfect methods, leave at least a large group of such cases without any evidence of infection. Such observations as Flexner's in regard to the hemorrhagin of snake-venom, and those of workers on anaphylaxis regarding the production of hemorrhages in that condition, suggest the possibility of a toxic origin of this disease, but experiments with the blood of such cases *in vitro* and injected into animals have failed to prove the presence of such a toxin.

The little light which has been shed on the nature of these troubles has come from studies connected with the coagulation of the blood.

The view which is now generally accepted regarding the process of blood coagulation is essentially that of Morawitz, and based upon his investigations. According to him, fibrin is formed by the union of fibrinogen and thrombin, also called fibrin ferment. Thrombin owes its existence to the combined

Digitized by Google

presence of thrombokinase, calcium, and prothrombin or thrombogen. Morawitz also believes that there is normally in the circulating blood an antithrombin, which is essential in maintaining its fluidity while circulating. There is, moreover, evidence that the activity of the liver is necessary to the coagulability of the blood. Shutting off the abdominal circulation, injury to the liver, or its extirpation makes the blood noncoagulable. Under these circumstances there is lack of fibrinogen. Wolff claims to have also demonstrated that the liver forms substances which hinder fibrinolysis.

In the clinical study of the coagulation of the blood several new devices and improvements upon old methods have been used. Sir Almeroth Wright's method of determining the coagulation time by means of his capillary pipettes has been the basis of many interesting reports and suggestions from him, but too much reliance must not be placed on his findings. His method of determining the moment of coagulation is rather crude, and the method leaves largely out of account the great variations in the time of coagulation which may be produced by variations in the temperature. The accompanying chart (Fig. 1), made up from Addis's figures, shows how greatly the time of coagulation depends upon the surrounding temperature. A method which is now in quite general use is that which uses the coagulometer of Brodie and Russell, or a slightly modified one of Boggs, in which a stream of air keeps the drop of blood in motion until it coagulates, the cessation of motion being watched for through the microscope. This method has been made more accurate by Addis, who, instead of air, uses a constant stream of oil at a fixed temperature. Another means of determining the coagulation time which is probably still more accurate is the method of Doctor Kottmann, using his "coaguloviscosimeter." In this instrument a metal disc hangs in a

Digitized by Google

small revolving cup containing the blood. The tension of the wire supporting this disc indicates the advance of coagulation by a pointer and a dial. The readings from this dial at regular intervals of time may be plotted into a curve, giving such results as are here shown. (Fig. 2.) Unless these very accurate methods are used, the simple old method of Milian, modified by Hinmann and Sladen, and again by Duke, is perhaps as satisfactory as any of the others in common use. That method consists in putting a drop of blood of a diameter of 5 mm. upon a glass slide, keeping it inverted over a glass of water at 40° C. and covered with a warm, damp cloth, and at frequent intervals tipping the slide into a vertical plane to see whether the blood has set or still sags. The normal coagulation time by this method is from 5 to 7 minutes.

The bleeding time may be approximately obtained by following a recent suggestion of Duke's and making a slight cut in the tissue of the skin, sopping up the drop of blood on a piece of blotting paper every half minute until the blood ceases to appear. The number of spots on the paper then indicates the duration of the bleeding. He has observed a number of cases in this way and claims to have obtained fairly constant or consistent results.

The counting of blood platelets is done in two ways, the direct and the indirect. By the direct method they are counted very much as the white cells are counted, using the ordinary pipette and a solution of cresyl blue with potassium cyanide. This solution lakes the red cells and stains the white cells and platelets. The normal number of platelets in 1 cu. mm. by this method is 225,000 to 400,000. By the indirect method the ratio between platelets and red cells is determined in a stained smear, and the red cells of the same blood are counted in the usual way. A report on the direct method was read at

Digitized by Google

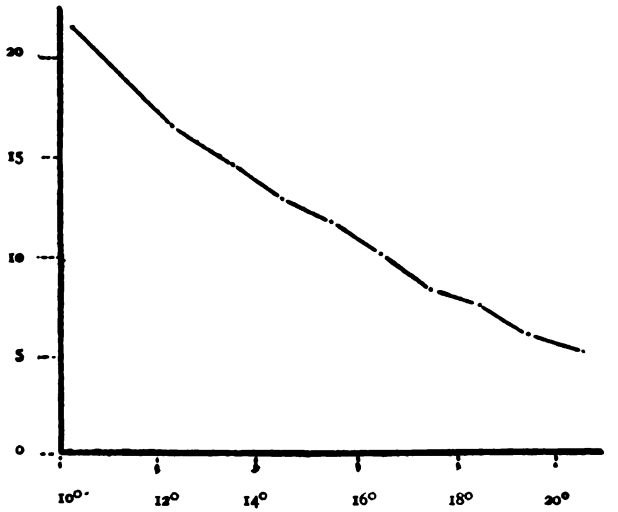


FIG. 1.—Times in which the same blood coagulates with different temperatures. The figures in the vertical column denote the coagulation time in minutes; the temperatures in the horizontal line are of the centigrade scale. (Plotted from Addis's figures—Brodie-Russell Oil Method of Addis.)

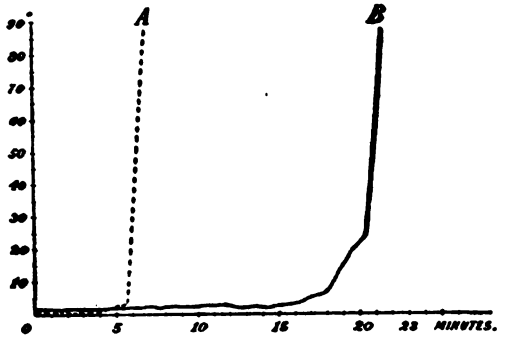


FIG. 2.—Coagulation curve of normal blood; A, at 40° C.; B, at 20° C. (Kottmann's Coaguloviscosimeter.)

Digitized by Google

the last meeting of the Association of American Physicians by Wright and Kinnicutt. Pratt believes that the indirect method is more accurate. It gives rather higher figures.

Retraction of the blood clot is studied by putting about 3 c.c. of the patient's blood into a small test tube and watching it. Normally, at the end of an hour it begins to be separated from the wall of the tube. At the end of 24 to 48 hours the contraction should be complete and the clot entirely surrounded by a layer of serum.

The study of cases of hemophilia and purpura by these methods has given results in which the various observers for the most part agree.

In true hereditary hemophilia the varied experience of investigators has shown that it is the rule to find an increase of the coagulation time, often to a very high degree. As Sahli says, "the single characteristic feature of hemophilia is the prolonged coagulation time." This he attributes to a diminished content or diminished availability of the thrombokinase in the blood corpuscles. One of the latest and most careful contributions to this phase of the subject is given by Addis, who has carefully tested twelve cases of typical hereditary hemophilia. Using the oil modification of Brodie and Russell's instrument, which gives with normal blood at a temperature of 20° C. a coagulation time of about 10 minutes, he found that in nine of these twelve cases the time was from 63 to 85 minutes. In one case in which the symptoms were of moderate degree, 36 minutes, and in the remaining two cases, in which the symptoms were slight, 15 minutes. While this increase in the coagulation time is as a rule marked in these cases, it is, on the other hand, the general experience that they show no diminution in the number of platelets and no failure of the clot to contract.

Digitized by Google

Digitized by Google

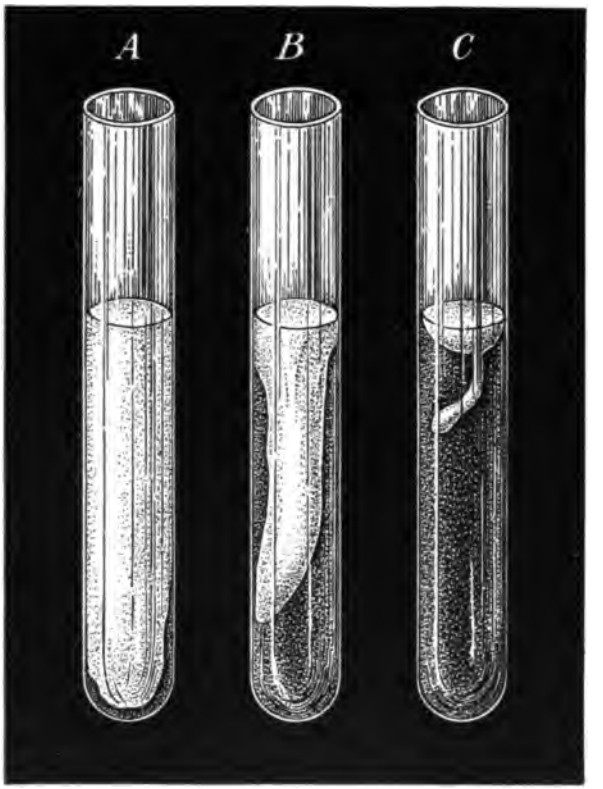


FIG. 3.—Reduction of clot with increasing amounts of platelets; A, oxalate serum + calcium chloride; B, the same + a few plates; C, the same + a large number of plates.

Digitized by Google

In cases of jaundice with hemorrhage the coagulation time has also been found to be greatly increased.

In purpura, on the other hand, the coagulation time is as a rule normal. Pratt, using the Brodie and Russell instrument, found in thirty-four cases an average of 5½ minutes, which is well within the limit of his observations on normal cases. In the records of twelve cases in the Presbyterian Hospital I find the coagulation time recorded as not over 8 minutes in eight cases, and in the other four cases 9, 10¼, 10¾, and 11¼ minutes, respectively. Occasionally instances have been reported in which the coagulation time was delayed, but as a rule purpura, in this respect, differs markedly from hemophilia. The platelets, however, in cases of purpura with hemorrhage are generally much reduced in number and there is failure of the clot to retract. It is even thought by some that cases of purpura without eruption may be recognized by the diminution of platelets and the non-retraction of the clot. There is experimental evidence that the clot retraction depends upon the abundance of platelets. (See Fig. 3.)

Duke's observations on the bleeding time, made with his rather crude method in a few cases of purpura hemorrhagica with a low platelet count, found that though the coagulation time was normal the bleeding time was greatly prolonged, to 60 minutes or more, instead of the normal 1 to 3 minutes. In two cases of Henoch's purpura with a normal number of platelets he found the bleeding time normal, and in some cases of jaundice with greatly increased coagulation time the bleeding time was normal.

Further studies into the nature of purpura with low platelet count are suggested by experiments showing that the number of platelets in the circulating blood may be experimentally reduced. They may be reduced by injections of albumose. More-

Digitized by Google

The use of gelatin by mouth is of doubtful efficacy, its use hypodermically is of some danger, and Boggs' experiments failed to show that gelatin reduced the coagulation time of the blood.

Weil, after showing that normal serum either from man or from animals, as well as pleuritic fluid, has a marked effect on the clotting of hemophilic blood, tried the use of normal sera clinically in a few cases of hemophilia and purpura, with fair results. Leary used normal rabbit serum, in doses of 15 c.c. intravenously, or 30 c.c. subcutaneously, in nine cases of jaundice with hemorrhage, three cases of hemorrhage of the newborn, one of hemophilia, and one of purpura, obtaining in general favorable results. The most striking success with the serum treatment of hemorrhagic conditions is that reported by Welch. He used normal human blood serum subcutaneously in nine cases of hemorrhage of the newborn. In every case the hemorrhages stopped promptly after the administration of serum. The one child who died lived forty-nine days after the cessation of hemorrhage. Compared with the high mortality in such cases, these results are very striking. It must, however, be remembered that hemorrhage of the newborn is in all probability of a different nature from purpura and hemophilia.

Transfusion has also shown a striking efficacy not only in hemorrhage of the newborn, as in Lambert's case, but also in purpura. Duke reports a case of acute purpura hemorrhagica with a platelet count of 6,000 and 3,000, a bleeding time of 47 minutes, 90 minutes, and 50 minutes, but with normal coagulation time. Six hours after transfusion the platelet count was 123,000, the bleeding time 3 minutes, the coagulation time unchanged. After a few days the platelet count and bleeding time had gone back to near their previous figures, but after

Digitized by Google

FIG. 6.

Digitized by Google

FIG. 7.

Digitized by Google

this, without further transfusion, the blood gradually resumed a normal condition and retained it.

In looking over the histories of cases of purpura which have come into the Presbyterian Hospital, in which eruptions, hemorrhagic, erythematous, urticarial, and edematous, hemorrhages from the mucous surfaces, pains in the joints and in the abdomen, and evidences of nephritis occurred in various combinations and various degrees, I find two cases of special interest.

The first, a young man of 25, well developed and well nourished, and after his recovery presenting a picture of sturdiness and general good health, was remarkable for the extent and the intensity of the superficial lesions. These were hemorrhagic, erythematous, urticarial, and edematous. The hemorrhagic spots varied from small petechiæ to large hemorrhagic areas a couple of inches in diameter, some bright red, some dark, almost as if necrotic. They were found upon the mucosa of the mouth and pharynx as well as upon the skin. Some of the erythematous spots presented red circles with white centers, some of them red areas with darker red centers, some more than two zones of different shades. Some were crescentic. Some of the spots were sharply raised and firm; that is, distinctly urticarial. Edematous areas accompanied the other changes in the skin, appeared over painful joints, and again were independent of both. At one time the scrotum became edematous and a circumscribed area of edema appeared on one side of the penis. These different appearances came and went with utter irregularity. More than once his eyes were completely closed by the swelling of the lids, and at one time his nose looked as if it would slough off. The accompanying photographs show his appearance at different times. (Figs. 6 and 7.) Different joints were at times quite painful, and he had

Digitized by Google

some severe attacks of abdominal pain. The heart showed signs of mitral and aortic regurgitation. He gave a history of previous attacks of arthritis. The urine at first showed marked signs of nephritis, but afterwards became normal. The hemoglobin came down from 90 per cent. to 50 per cent., but afterwards went back to 90 per cent. again. The blood platelets were twice counted, giving 336,000 and 276,000. The coagulation time was taken twice and found to be 6 minutes and 7 minutes.

He was treated with salicylates, which sometimes seemed to relieve his pain; with chloride of iron and ergot, without apparent effect, and finally with oil of turpentine, which appeared to inaugurate his convalescence.

He felt and seemed to be perfectly well when he left the hospital.

Another striking case, on Dr. Eliot's service, had had previous attacks of arthritis following gingivitis, and followed by the appearance of purpuric spots on the hands and fingers. She had also had some hemorrhagic eruption on the body. Upon admission she complained of pain in the left flank and left hypochondrium, which she said she had had for three months. She had vomited during the day, first undigested food, later some yellowish material, and in the hospital a good deal of dark, thick material resembling prune pudding. She was markedly anemic, the gums swollen and angry, with purulent material exuding between the teeth, tender, and bleeding, and at one point ulcerated. The abdomen symmetrical, slightly distended, rigid all over, and markedly tender. Over the arms, chest, back, and legs a profuse hemorrhagic eruption, the spots varying in size from a pinhead to small blotches. The pulse was small and very rapid. From time to time the patient

Digitized by Google

writhed in pain. After she had been in the ward about two hours she became suddenly worse, going into collapse, the abdomen became very hard. Laparotomy was performed by Dr. Eliot; the peritoneal cavity was found to be filled with gas and a large amount of dirty black fluid, with dark sediment containing stomach contents. Of the anterior wall of the stomach a portion was lacking, of the size of the palm of the hand, and extending from the greater curvature almost to the lesser, with a sharp border. Through this opening the mucous membrane of the posterior wall was visible. She died in a few hours. The autopsy found a large part of the anterior wall of the stomach lacking, as at the operation. Most of the remaining stomach wall was black, with the mucosa raised and thickened, excepting an area near the fundus, where the stomach wall appeared normal. Microscopical examination of the stomach wall showed in places the entire thickness necrotic, in other places the mucosa necrotic over a normal muscularis, the outlines of the necrotic areas being sharply defined.

Digitized by Google

VII.

TRANSFUSION OF BLOOD IN THREE CASES OF PERNICIOUS ANEMIA.*

By David Bovaird, Jr., M.D., Associate Visiting Physician.

"Transfusion of blood from a healthy individual to a patient with pernicious anemia," writes Cabot in Osler's Modern Medicine, "is not to be recommended and should not be done."

Some experience of the beneficial effect of transfusions in a patient suffering from malignant endocarditis had, however, impressed upon the writer the value of an influx of healthy blood to a patient suffering from a chronic poisoning. The experiment has, therefore, been tried on three patients suffering from pernicious anemia during the past year, with results of such importance as to lead to their publication.

Case I. Male, 54 years of age; single. The family and previous personal history were good. The patient could remember no illness before the onset of the present. No venereal infection. For 15 or 20 years he had used alcohol and tobacco to excess. Present illness began two years ago with nervousness, insomnia, and some weakness. For the past year he has been jaundiced at times but without pain. For one year he has had a slight cough. In January last his feet began to swell and the swelling gradually extended upward till hands and face were affected. He has been in bed for seven weeks. For one week during this time he vomited blood daily. At the same time he was very yellow and skin was tense. One and a half quarts of fluid were drawn off from the right pleural cavity. The jaundice and edema have gradually passed off. Recently he has been short of breath, with increasing weakness, pallor and headache.

Physical examination on admission. The patient is a thin, cachectic, anxious-looking man, greatly depressed mentally. The skin is dry and somewhat lemon colored. He suffers from some dyspnea but without cyanosis. The conjunctivæ are exceedingly pale, the scleræ slightly icteroid; the pupils normal. The ears are normal. The teeth are in fair condition, the tongue rather dry and somewhat coated. The tonsils and pharynx congested. The

(*Reprinted from the Medical Record, February 11, 1911.)

Digitized by Google

mucous membranes are all exceedingly pale. The lymph nodes are normal. The heart enlarged downward and to the left; both presystolic and systolic murmurs heard at the apex. The presystolic is limited to the apex, the systolic transmitted to the left axilla. A soft systolic blow is heard over the pulmonic valve. The pulses are equal, regular and of moderate tension; rate 92. Liver dulness extended from the fifth space to a point 10 cm. below costal margin in the nipple line. The edge was readily palpable, smooth, not tender. Spleen was apparently normal. Abdomen otherwise normal. Genitals normal. Extremities wasted but free from edema. The urine was of normal quality and specific gravity with a trace of albumin and at times hyalin casts. The urine also showed a trace of bile, but no indican. The feces showed no parasites or ova. The blood examinations indicated a pernicious anemia. The cardiac changes were regarded as probably due to an old and well-compensated valvular lesion. The enlargement of the liver was accounted for by the protracted alcoholic habit.

The patient was so lethargic that it was difficult to feed him. Iron and arsenic were ordered but had to be stopped in a few days because of nausea. Day by day the patient became paler, more stupid, and more dyspneic, till it seemed as though he must surely die unless helped by some vigorous measure. He was finally confined to bed and apparently moribund. At this juncture a transfusion was determined upon and arranged for by his friends, the patient being by that time almost comatose and quite incapable of discussing the subject for himself. A young and vigorous man, fresh from the plains of Texas, was found to fill the part of the donor, and the transfusion was done on April 25 by Dr. Eliot. The immediate effect of the transfusion was impressive. The color could be seen slowly gathering in the apparently bloodless lips and cheeks, which from chalky pallor quickly changed to healthy red. Even on the operating table the patient roused and began to speak readily and naturally. The following day he was found sitting up in bed looking very comfortable, and greeted his physician with the query as to when he might go for a walk! From that day on his progress was steadily upward. The hemoglobin had mounted from 25 per cent. to 50 per cent. during the transfusion. Five days afterward the hemoglobin was 60 per cent. and it mounted steadily to 85 per cent. on May 31. The general condition of the patient improved in like manner. His appetite returned; he digested his food well. He was soon allowed out of bed and spent much of his time out of doors. The records of the blood examinations are given below.

From the hospital the patient went to Delaware Water Gap, where he continued to gain. He ate well, felt well, and walked from six to eight miles a day. This condition continued till the end of July, when he began to lose his appetite, and gradually became weaker and paler. About September 1 he became jaundiced and was sick for two days with nausea and vomiting. Soon afterward he suffered a severe fall and was unable to rest or sleep, from pain in the left hip and side. He failed steadily and returned to the hospital October 23, in much the same condition as he had entered in

Digitized by Google

April. The physical examination was practically the same as that given above, except that the patient was brighter, a little less anemic, and appeared to still have some energy. Examinations of the urine and feces resulted as before. From the time of his admission the patient failed steadily despite our best efforts by feeding, medicines, fresh air, and sunshine to stop the progress of his disease.

Date	Apr. 13	Apr. 14	Apr. 20	* May 8	May 17	May 31
R. B. C.	1,100,000	836,000	806,000	3,100,000	4,568,000	4,296,000
Hg.	35%	25%	25%	62%	78%	85%
Index	1.6+	1.5	1.5	1.0	.85	
W. B. C.	8,500	9,000	8,000	11,000	7,500	
Differential						
Polynuclears		77	69	86	61	
Transitionals		0	4		5	
Large mononuclears..		1.3				
Lymphocytes		18.0	27.0	14	32.5	
Basophiles		0	0		0.5	
Eosinophiles		1.3	0		1	
Myelocytes		1.7	1			
Megaloblasts		2	1			
Normoblasts		4	1			
Polychromatophilia ..		+				
Poikilocytosis		+				
Basophile granulation		+				
Anisocytosis		+				

* Transfusion April 24th.

Date	Nov. 1	Nov. 17	Nov. 26	Nov. 26†
R. B. C.	1,512,000	872,000	2,764,000	2,688,000
Hg.	46	23	62	62
Index	1.5	1.4	1.1	1.1
W. B. C.	9,800			
Differential				
Polynuclears	67	64	74	
Transitionals		1	3	
Large mononuclears...				
Lymphocytes	29	29.6	20	
Basophile		.6	.6	
Eosinophile	1	.6	1.0	
Myelocytes	.2	4	1.3	
Normoblasts	1	71	0	
Megaloblasts	2	+		
Polychromatophilia ...	+	+	Moderate	
Poikilocytosis	+	+	Moderate	
Basophile granulation.	+	+	Moderate	
Mitotic red cells		2		

† Second count.

A table of blood examinations made at this time will be found above.

Digitized by Google

As all other efforts failed a second transfusion was proposed, assented to, and the effort to secure a donor instituted. Meanwhile the patient gradually passed into a state of extreme anemia, with lethargy, anorexia, insomnia, and depression as shown before. Then suddenly, without apparent cause, he began to mend. The blood picture within a week changed so remarkably that the staff examiner, who had been making all the examinations, thought the transfusion had been done without his knowledge. Coincidently the general condition changed accordingly, the patient's appetite returned, he ate heartily, slept well, gained in strength, and again left the hospital on November 29, able to get about freely and enjoy being alive.

CASE II. Male, 59 years; married. In 1908 the patient had typical pernicious anemia. At that time he improved slowly but steadily under symptomatic treatment and at the end of several months resumed his occupation. He continued to work until May 27, 1910. For a year he had been troubled by swelling of the legs, dyspnea, and weakness, and ulcers had been gradually developing on various parts of his body, the legs especially.

The points of interest in the physical examination were the extreme anemia with well-preserved fat, edema of the ankles and legs, numerous ulcers over both legs. The urine and feces were negative. The blood showed 18 per cent. hemoglobin, 844,000 red cells; 3,500 white cells; monoblasts, megaloblasts, and the variations in shape, size, and staining characteristics of severe anemia.

The effort was again made by rest, careful feeding, fresh air, colonic irrigations, iron, and arsenic, to help him as on the previous occasion, but without success. The blood showed improvement for a time, but then failed again; the hemoglobin and red cells standing on September 8 practically where they were at the outset. On September 16 the red cells numbered 1,080,000; the hemoglobin 18 per cent.; the white blood cells 7,200. A transfusion was determined upon, but great difficulty was experienced in finding a suitable donor. Two applicants were tried but rejected because hemolysis resulted from the admixture of their blood with that of the patient. A suitable donor having finally been found Dr. Woolsey attempted to effect the transfusion by joining vein to vein (median-basilic), but finding that the pressure in the patient's vein was higher than that of the donor was obliged to give up the method. The donor then refused to have an artery used to replace the vein and we were forced to begin anew. Another donor was finally found, who proved satisfactory on physical examination, and whose blood was suitable. The transfusion was then done by Dr. Woolsey on September 26. The union of vein and artery was made satisfactorily but the exchange of blood had to be stopped on account of faintness of the donor when the patient's hemoglobin had reached 35 per cent. Immediately after the operation the patient's temperature began to rise and mounted steadily to 106°. On the following day, the patient breathed with much difficulty, became dull, and then comatose. The face and eyelids became swollen and puffy, and the trunk and extremities were covered everywhere by great blotches of eruption, partly urticarial and partly hemorrhagic. At the same time it was discovered that the blood of the patient con-

Digitized by Google

tained many malarial parasites, and that the same parasites were to be found in that of the donor! The donor insisted that he had never had malaria and that he was perfectly well at the time. Examination of the patient's blood showed no change in the hemoglobin, the urine showed no blood pigment, and we therefore concluded that no hemolysis had taken place, but that the phenomena described were in the nature of an anaphylactic reaction to the foreign serum. The bloods had been tested before the transfusion. These tests were repeated afterward and the two were shown to harmonize. The question of the possible influence of the malarial parasites was, of course, raised. The patient had no chill. The rise of temperature was a gradual ascension during 24 hours, the fall occupied three days, and there was no sweating. Quinine was given intramuscularly and by mouth. The parasites disappeared from the blood in four days and there were no later evidences of their presence or influence. For a time the patient professed to feel better and appeared to be somewhat benefited by the transfusion, but the hemoglobin steadily fell till on November 3 it had again reached 18 per cent. He had slowly become weaker, paler, more dyspneic, and finally succumbed on November 4. No autopsy was permitted. The case is reported not only as a failure of the method, but to point out a danger which we had overlooked, a latent malarial infection in a person apparently in perfect health. A search for malarial parasites in the donor's blood must now form part of the preliminary examination. There is little doubt that this latent malaria was the explanation of the quickly developed faintness of the donor, which interrupted the transfusion before the patient had received a sufficient quantity of blood to materially help him.

Case III. Woman, aged 35 years; married. The family history was negative. Previous personal history of scarlet fever and diphtheria in childhood, and pneumonia at seventeen. She was always sickly as a child. She had had no children, no miscarriages. She occasionally drank beer or whiskey, much tea, no coffee.

Present illness began one year ago with loss of appetite, frequent vomiting, and swelling of the legs. She knew no cause for her illness. Ever since she has been very pale and her legs have been swollen at times. Her menstruation has lasted but one or two days and has been very scanty. Lately her sight has been poor. She has not vomited recently, but food has oppressed her. Her appetite is always poor, the bowels regular, urination normal, sleep fair. She is very nervous.

Physical examination: Extreme, almost death-like pallor, without marked emaciation. No dyspnea. Slight puffiness about eyes. Marked weakness and appearance of severe chronic illness. Ears: normal. Eyes: conjunctivæ, extremely pale; pupils normal. Teeth: upper set entirely gone, a few in lower jaw. Tongue and mucous membranes extremely pale. Throat pale; subcutaneous lymph nodes, not palpable. Skin very white, otherwise normal. Neck and thorax, normal.

Digitized by Google

Heart: Apex impulse visible and palpable in fifth space, 9 cm. to left. Left limit of dullness, 10 cm. to left midsternal line. Right border beneath sternum. Over the heart is heard a soft, blowing systolic murmur transmitted into left axilla, while along the left sternal margin and in the third and fourth spaces is heard a faint murmur, diastolic at times. The aortic sounds are very faint, no murmurs, no accentuation.

Pulses are small, equal, regular, correspond to apex, soft; rate 90, the wall of artery not felt. Lungs normal. Liver, not palpable; dullness normal. Spleen not palpable. Abdomen normal. Extremities, upper normal, except for pallor; lower puffy, without edema. Knee jerks, sluggish; other reflexes, normal.

On admission the hemoglobin was 10 per cent.; red blood cells, 700,000. The urine amounted to 30 ounces, sp. gr. 1.013, a faint trace of albumin, many hyalin and granular casts. A later examination showed no casts. The feces showed no ova, no parasites. Bacteriologically the stools showed no marked divergence from normal. The patient was extremely lethargic, and day by day became more stuporous till she was difficult to rouse. She took very little nourishment, and it appeared certain that she could live but a few days. The temperature ranged from 99° to 102°. Under these conditions transfusion was decided upon as the only means of giving her a chance for life. The first donor's blood proved incompatible, but a second with an harmonious blood was secured.

The transfusion was done by Dr. Woolsey, September 29.

At the time of the operation the patient's hemoglobin registered 13 per cent.; at the end of the transfusion, 45 per cent.

The improvement in color and general condition was immediate. The following day she was apparently much better, although rather irrational. Forty-eight hours after the transfusion the patient's condition became worse. The mind became more clouded and she became noisy. The pulse was weak, the face puffy, the conjunctiva slightly icteroid, there were many râles in the lungs, and much mucus in the throat. Under stimulation she rallied and proceeded to make a rapid recovery. The temperature after ten days became normal, the mind became clear, the blood improved, and with it the patient's vigor. By October 17 she was able to begin walking, and on November 6 she was sent home in excellent condition with over 80 per cent. hemoglobin and 4,104,000 red cells. One month later she was still in excellent condition, able to get about and lead her usual life.

This patient was last seen January 10, 1911. The report of the blood examination at this time is included in the table on page 14. She appeared to be in good health, reported herself as feeling well, enjoying a good appetite, sleeping well, and so vigorous that she expects to resume her usual household duties.

Digitized by Google

Of these three patients with pernicious anemia upon whom transfusion has been tried, two have benefited to the extent of prolonging their lives for months; in the other patient the benefit was so slight and transitory as to amount to nothing. The question naturally arises whether the conditions dealt with were true pernicious anemia. In the first case the suspicion may arise that we were dealing only with a profound anemia secondary to the hematemesis reported. The hematemesis was limited to one week, and the anemia had become progressively worse after its cessation, and despite efforts to improve the patient's condition. The absence of carcinoma or parasitic infection has been assured both by the clinical course of the disease and repeated examinations. The blood picture with its extreme paucity of red cells, high color index, megaloblasts, normoblasts, together with the stippling and the variability in the size, shape and staining of the red cells may be termed typical. Ehrlich's view that the prevalence of megaloblastic forms in the blood is essential to the diagnosis of pernicious anemia has not been borne out.

In a recent number of the Medical Record (October 29, 1910) Grawitz points out that macrocytosis is not so characteristic of this condition as microcytosis, and that indeed there is no constant blood formula. But whatever doubt might be entertained as to the diagnosis should be satisfied by the observations made on the occasion of the patient's return to the hospital in the fall. The sudden change from a grave condition to one of comparative safety, accompanied by the remarkable "normoblastic crisis," belongs to no other disease.

In the second case the diagnosis will hardly be questioned. Our experience with this patient, however, brought out forcibly some of the difficulties which beset transfusion. After the ex-

Digitized by Google

pediency of transfusion had been determined more than a month elapsed before a donor of any kind could be obtained. In this city appeal to various agencies having to do with the unemployed usually brings one or more candidates in a short time, but as it chanced to be midsummer, few men were looking for aid and apparently none of these cared to earn the fee offered for such service. When finally candidates did present themselves, two had to be rejected because of incompatibility of their blood with that of the patient. A suitable donor having finally been secured, the procedure failed by reason of the attempt to use the vein-to-vein transfer instead of artery to vein. Transfusion having finally been accomplished from a fourth donor, the process had to be stopped by reason of faintness on the part of the donor, and the discovery was made that the donor had a latent malaria, although apparently in perfect health, and that the patient's blood also contained malarial parasites. Although the prompt administration of quinine destroyed the parasites and prevented any ill result from their presence, the malarial infection was of considerable importance as doubtless determining the faintness of the donor and the early cessation of the transfusion.

The severe anaphylactic reaction which followed the transfusion in this case was also noteworthy. The third patient also experienced a reaction, but of much less degree. Tests of the bloods, both before and after the transfusion in the second case, had shown their harmony and the severe reaction would appear to be a result of the introduction of a large quantity of foreign serum, and to concern the tissues of the body, especially the lungs and skin, rather than the blood itself. The violence of the reaction in the second patient threatened his life. In the third patient the reaction was not quite so severe.

Digitized by Google

The third patient was a woman of 35 years. The absence of any sufficient cause for so grave an anemia, the clinical picture, and the blood findings established the diagnosis of pernicious anemia as firmly as is possible under the conditions.

Date	Sept. 22	Oct. 4*	Oct. 25	Nov. 2	Jan. 10, 1911
R. B. C.	710,000	3,630,000	3,410,000	4,104,000	4,432,000
Hg.	13%	62%	75%	82%	75%
Index	.9+	.86	.97	1—	.8+
W. B. C.	3,200	7,300	9,600		5,400
Differential					
Polynuclears	23.3	92.9	66.4		51.0
Transitional	2.8	.3	4.8		2.0
Large mononuclears	1.0	.2	4.0		9.0
Lymphocytes	72.0	6.3	23.2		38.0
Eosinophiles	0.0	0			0
Basophiles	0.0	0	.6		0
Stimulation	0.7	.3	.2		0
Myelocytes	0.7				0
R. B. C.					
Pallor	Marked	Moderate	Slight		Slight
Polychromatophilia	Marked	Slight	0		0
Poikilocytosis	Marked	Moderate	0		0
Basophile granulations	Marked		0		0
Normoblasts	2	0	0		0
Megaloblasts	1	0	0		0
Gigantoblasts with Mitoses	2				

* Transfusion September 29th.

Results of transfusion: 1. Immediate. The transfusion after union of the vessels occupies an hour or more, as a rule. During that time the appearance of death-like pallor which these patients present changes to that of comparative health. The color first reappears in the cheeks and tongue and then mounts in the lips, the conjunctivæ, and the skin generally. The hemoglobin can easily be followed, and in a Dare's or Fleischl's instrument shows a steadily increasing percentage.

Digitized by Google

In the two favorable cases this amounted to an increase of three or four times the original percentage. There is a corresponding change in the patient's mental condition and vitality, which seems, in patients so near to death, almost miraculous. This was strikingly true in the first case.

2. Secondary. In both the favorable cases the transfusion introduced a period of improvement which in the first case has now lasted nine months, in the third, two. The hemoglobin and the number of red cells have increased steadily until 80 per cent. and more has been attained.

The general vigor and well-being have been correspondingly improved. The relapse and recovery observed in the first patient show clearly that equally remarkable improvement may be observed without transfusion, yet when the hemoglobin falls below 20 per cent. and the patient becomes comatose waiting for natural recovery regularly proves vain.

How long the improvement secured in our two patients will continue no one can say. The disease is, of course, not cured, and relapse with its usual outcome is to be expected.

Our experience seems to indicate that as a last resort transfusion of blood in pernicious anemia offers the possibility not only of averting death, but for a time at least restoring the patient to comparative health and comfort and initiating one of the periods of quiescence so characteristic of the disease.

Transfusion in this condition is fraught with perils of its own, first from immediate hemolysis of the new blood, secondly from the effect of the new serum such as occurred in two of our patients, an effect apparently in the nature of an anaphylactic reaction. The first danger can be avoided by careful preliminary studies of the two bloods, the safety of the red

Digitized by Google

cells of both patient and donor being assured by testing them in the serum, each in that of the other. Whether a patient can be guarded against the possibility of a serum reaction by preliminary testing of his susceptibility to a small quantity, as may be done with diphtheria or other antitoxic sera, is a question for future experience.

NOTE, October, 1912. The patient described as Case I lived till about February 1, 1911, and was not seen in his last illness, but from the accounts given by his friends the symptoms were the same as in his previous crisis of anemia, and he presumably died of that disease. The patient described as Case III was seen in May, 1911, when she was apparently in good health and was about to go to work in Magnolia, Mass., for the summer. In August she returned to the city and died in Bellevue Hospital. An autopsy was performed and the lesions found were those of pernicious anemia.

It may therefore be fairly said that each of these patients lived nine or ten months as the result of direct transfusion of blood.

Digitized by Google

Digitized by Google

VIII.

CONCERNING THE PRESENCE OF THE EMBRYOS OF TRICHINELLA SPIRALIS IN THE BLOOD OF PATIENTS SUFFERING FROM TRICHINIASIS.*

By Albert R. Lamb, MD., Resident Pathologist.

It is now two years since Herrick and Janeway[1] first demonstrated the embryos of Trichinella spiralis in the blood of a patient suffering from trichiniasis. This most interesting and important finding came as a logical sequence of Staübli's[2] previous experimental work on the mode of dissemination of the embryos in guinea-pigs.

And yet, in spite of the time which has elapsed since this discovery was announced, I have been able to find the reports of but four additional cases.

During the past winter at the Presbyterian Hospital, New York, 4 cases were investigated with special reference to this point. In 2 of these the embryos were found in the blood. In the other 2 several specimens of blood were thoroughly searched with negative results. Of the negative cases, one was proved to be trichiniasis by the demonstration of the parasites in the muscle, while the diagnosis in the other was never definitely settled.

Trichiniasis is a disease in which the diagnosis may often be made with a fair degree of certainty by the history, physical

*(*Extracted from the American Journal of the Medical Sciences, September,* 1911.)

Digitized by Google

signs, clinical course, and the eosinophilia, without recourse to the examination of the blood or muscle for parasites. In these well-marked cases there is, perhaps, no great urgency for the use of further means of settling the diagnosis, except in so far as every case is more satisfactory when worked out to the limits of its possibilities.

There are, however, many cases in which the diagnosis is by no means so clear, and in which every means at our disposal must be employed to settle the nature of the disease. Two cases of those reported in this article illustrate this point.

In one, the patient was admitted to the hospital with a diagnosis of typhoid fever. A blood culture being sterile, a Widal negative, and the temperature falling to normal in the course of three days, this diagnosis was abandoned and the case was being considered one of influenza, when an embryo of Trichinella spiralis was recovered from the blood. Subsequent to this the eosinophiles, which had previously not exceeded 5 per cent., rose to 14 per cent.

The other case was even more interesting, although the diagnosis was, unfortunately, never settled definitely. The patient, a woman, was admitted to the hospital with an eighteen-day history of gastro-intestinal symptoms and fever, followed by urticaria and purpura. When admitted, the eruption was marked, but she had no fever. The leukocytes varied between 25,000 and 43,000, and the eosinophiles between 0.3 per cent. and 75 per cent. Her husband was later admitted to the hospital, having been taken ill eighteen days after his wife. A piece of muscle removed from his calf showed many trichinellæ. All possible means of settling the diagnosis in the woman were resorted to. A blood culture was sterile, no ova or parasites were found in the stools, examination of the blood for embryos was negative, and a piece of excised muscle showed

Digitized by Google

only "interstitial myositis," similar to that produced by trichinellæ. From the history of the case, the leukocytosis and marked eosinophilia, the muscle findings, and the fact that her husband was suffering from trichiniasis at about the same time, it seems not improbable that the patient was a victim of that disease. The case is interesting from its relation to that little understood group of cases known as "idiopathic purpura." The future examination of the blood for parasites in cases similar to the above may show that in a few the underlying condition is trichiniasis.

METHOD OF EXAMINATION. Staübli's[3] original method of diluting the blood with ten volumes of 3 per cent. acetic acid was used, the only modification being that, in several instances, the blood was obtained from the blood cultures taken on the patients. These cultures were the usual routine ones, used in the hospital, 10 c.c. of blood being divided between two Erlenmeyer flasks of meat infusion broth. After the culture had been reported sterile, the clear supernatant broth was decanted and ten volumes of 3 per cent. acetic acid were added to the sediment. The mixture was thoroughly shaken, centrifuged, and the supernatant fluid poured off. If the resulting sediment was too thick, the laking with the acid was continued until a sediment was obtained in which the search was unhampered by the presence of countless numbers of red blood cells. A drop of the sediment was then poured on a large slide, covered with a good-sized cover slip, and systematically searched with a low-power lens.

The embryos appear as distinct, cylindrical, generally slightly curved little worms, with a refractile outline and a characteristic granular internal structure (see illustration). Both ends are somewhat rounded. The anterior end is a little

Digitized by Google

narrower than the rest of the body, and ends in a little, clear, homogeneous cap. The obliquely placed clear band, mentioned by Staübli,[4] as forming a line of demarcation between the anterior quarter and posterior three-quarters of the body, was not observed in the embryos studied. According to him, this band is especially well seen in the stained preparations. Foreign substances in the sediment, such as cotton fibers, thin plugs of red cells, and fungus growths, may at first cause some confusion, but when once seen, the embryos are quite characteristic.

The embryos found in the present cases measured from 0.005 to 0.007 mm. in breadth and from 0.1225 to 0.1295 mm. in length.

By rimming the cover slip with vaseline or cement, the preparation may be preserved for several weeks.

Numerous smears of the sediment were stained by various methods, but none of the parasites could be found. Herrick and Janeway had a similar experience. Staübli, however, had no difficulty in obtaining stained specimens which show the clear band at the anterior part of the parasite very distinctly.

None of the parasites was found in the stools.

The following is a brief review of the cases examined. They were all admitted to the Second Medical Division, and I am indebted to Drs. James, Kinnicutt and Bovaird for permission to use the clinical facts here given.

Case I. A woman, aged twenty-nine years, was admitted to the hospital on December 21, 1910. Eighteen days before admission, while working in the house, she was taken suddenly ill with pain in the upper part of her abdomen. This pain was severe, gnawing, continuous, and without radiation. At times her whole abdomen was tender. She had severe diarrhea, ten to twelve movements a day, the stools being foul and watery, but containing no blood. With the onset of pain, she complained of headache. She suffered from these symptoms much of the time for nine days, when she entered the Norwegian Hospital, where it was at first thought that she was suffering from typhoid fever. During the week that she remained there she suffered from soreness and stiffness of the left side of her neck. There were two epistaxes.

Digitized by Google

Digitized by Google

Embryo of trichinella spiralis in blood sediment from Case II. The microphotograph was taken by Dr. Hugh Auchincloss, New York.

Digitized by Google

All of her symptoms cleared up and she left the hospital feeling well. Three days before admission to the Presbyterian Hospital, after drinking a glass of wine, the pain in her abdomen returned. It was relieved by vomiting and did not again appear. Two mornings before admission she noticed itching of her legs, and found them covered with large, raised, white blotches. The next day the eruption appeared about her waist, and on the morning of admission on her arms.

Physical Examination. Old herpes on lip. No puffiness of the face. Spleen not palpable. There is a remarkable purpuric, and in places ecchymotic, rash covering a large part of her body. The face, thorax, and upper part of the abdomen are not involved.

There was at no time any muscular tenderness. She had no fever. The rash gradually faded in the course of a week, but not without the appearance of fresh spots. She left the hospital on January 17, in good condition.

Seven blood counts showed a leukocytosis varying between 25,000 and 43,000, and an eosinophilia between 0.3 per cent. and 75 per cent. On several examinations no ova or parasites were found in the stools. A blood culture taken on admission was sterile and no parasites were found in the blood sediment from this culture.

Three days after admission 10 c.c. of blood were drawn from an arm vein and examined for parasites, but with negative results.

Three weeks after admission a piece of muscle was excised and examined. The pathologist returned the following report: "Between the muscle bundles is a slight increase in the fibrous tissue in spots and deposits of small numbers of lymphoid cells. The changes are similar to those produced by trichinæ. No trichinæ found. Diagnosis, interstitial myositis, probably due to trichinæ."

CASE II.—A man, aged twenty-nine years, was admittted to the hospital December 29, 1910, with a history of malaise and chilliness for nine days. Four days before admission he went to bed with these symptoms, plus general muscle pains and swelling of the face and hands. He had no gastro-intestinal symptoms at any time. His brother was taken ill at the same time, and it was found that they had both eaten pork of their own cooking shortly before the onset of their illness. The brother entered a hospital in Pennsylvania, and it was impossible to obtain a specimen of blood for examination.

Physical examination showed nothing abnormal except a fine, punctate rash over the abdomen, thorax, and arms.

For three days he had a temperature in the neighborhood of 103°, gradually falling to normal.

The blood count showed 10,000 leukocytes and 11.5 per cent. of eosinophiles. A blood culture taken on admission was sterile. From this culture four embryos were found.

The patient refused permission to excise a piece of muscle.

CASE III.—A man, aged thirty-four years, the husband of Case I, was admitted to the hospital on December 31, 1910, with a ten days' history of

Digitized by Google

malaise, chilliness, and indefinite pains in the back of his neck and in his limbs. At times he noticed puffiness of his eyes. He had eaten pork three weeks before admission.

Physical Examination.—There is no puffiness of the face. He holds his head well turned to the right. Rotation causes pain in the posterior neck muscles, which are, however, not tender to pressure.

He had a temperature of 104°, gradually falling to normal in the course of three days.

His leukocytes varied from 15,000 to 23,000, and his eosinophiles from 2 per cent. to 41.3 per cent. The blood culture taken on admission was sterile. An examination of all the sediment from this culture was fruitless.

On January 5 a piece of muscle was removed from the calf. It was found to contain many embryos.

Following this finding another search of the blood was made on January 9. Ten c.c. of blood were drawn from an arm vein directly into 3 per cent. acetic acid. No embryos were found in the sediment.

CASE IV.—An Italian, aged twenty years, was admitted to the hospital on January 5, 1911, complaining of backache and general malaise for five days and indefinite pains in the bones, joints, and back for three days. At times he had rather mild, colicky pains in his abdomen. Had some fever.

Physical examination showed slight puffiness of the eyelids and cheeks, a coated tongue, palpable spleen, and a few fine, reddish punctate spots over the abdomen and chest. There was no muscular tenderness.

His temperature on admission was 104.4°, gradually falling to normal in the course of a few days.

Three blood counts were taken, as follows: January 5, leukocytes, 12,000; eosinophiles, 3 per cent. January 7, leukocytes, 12,400; eosinophiles, 5 per cent. January 12, leukocytes, 15,600; eosinophiles, 14 per cent.

A blood culture taken on admission was sterile. From this one embryo was recovered:

The patient would not consent to the removal of a piece of muscle.

There follows a list of the cases so far reported, together with those of the present series:

1. Herrick and Janeway.[5] April, 1909. They investigated 8 cases in one family. In 4 the blood was examined, but in 1 only were the embryos found. In that case they were found on two different occasions, on the tenth and twelfth days after the onset.

2. Packard.[6] April, 1910. The embryos were found in the blood twenty-two days after the onset. They were recovered from the muscle "a few days" later.

Digitized by Google

3. Barach and Mercur.[7] May, 1910. The parasites were found in the blood fourteen days after admission. The time of onset was not given. Sixteen days after the parasites had been found in the blood they were recovered from the muscle.

4. Cross.[8] September, 1910. Three embryos found on the eighth day after the onset. In this case only 1 c.c. of blood was taken. It was drawn from the lobe of the ear. Cross suggests that "it may be easier to obtain the parasites from the mixed arterial and venous blood than in the blood which has traversed the capillaries and is taken from the vein."

The patient would not consent to the removal of a piece of muscle.

Cases of the Present Series. 1. No embryos found on the nineteenth and twenty-second days after the onset. Six weeks after the onset a piece of muscle showed only "interstitial myositis."

2. Embryos found on the ninth day after onset. Muscle not examined.

3. Search for embryos negative on the thirteenth and nineteenth days after onset. Found in the muscle fifteen days after onset.

4. Embryos found on the sixth day after onset. Muscle not examined.

From the above it will be seen that the earliest time at which the embryos were found was on the sixth day after onset, and the latest twenty-two days after the begininng of the disease. In these cases the time of onset has been taken as the only available fixed date. It has many disadvantages over Staübli's method of reckoning from the time of eating the trichinellous

Digitized by Google

meat. But he was dealing with animals where the date could be easily ascertained, whereas with human beings it is very difficult to find out at what time they have eaten infected material. Indeed, it is often impossible to obtain a history of having eaten such material at all.

Staübli,[9] from his experiments with guinea-pigs, concludes that the birth of the embryos begins, at the earliest, six or seven days after infection, and that the maximum migration in the blood lies between the eighth and twenty-fifth days after eating the infected meat. He was unable to find embryos in the heart blood of guinea-pigs later than the twenty-seventh day after infection.

The variation in the incubation period of the disease is so great that it is impossible to accurately correlate the figures given above with those of Staübli. However, in general, it may be said that the time of maximum migration agrees fairly well in the two sets of cases.

Braun[10] is authority for the statement that the adult parasites continue to live and give off embryos for from five to seven weeks. This would certainly indicate that it may be possible to find the embryos in the blood at a later date than those given above.

There seems to be an impression that it is useless to search for the parasites in the blood after they have been found in the muscle. While no cases have been cited to prove the contrary, Packard found them in the blood only "a few days" before their recovery from the muscle. The first embryos reach the muscle on about the ninth or tenth day after infection, leaving a period of from two to three weeks when there is still a fair chance of recovering them from the blood.

Digitized by Google

CONCLUSIONS. 1. In the examination of the blood sediment for the embryos of Trichinella spiralis we have a valuable means of diagnosis in cases suggesting trichiniasis.

2. From the meagre number of cases so far reported, it would appear that the method had not been used as frequently as its value would merit. It must be remembered, however, that even under favorable conditions, this method is not infrequently unsuccessful.

3. The technique of the examination is very simple. While the search for the embryos is tedious, it is scarcely more so than the examination of the blood for the plasmodium of malaria.

4. The earliest time at which the embryos may be found in the blood is on the sixth or seventh day after infection. The latest date is not so accurately fixed. While the parasites have not been found later than the twenty-seventh day after infection in guinea-pigs, or later than the twenty-second day after the onset of symptoms in man, there is some ground for the belief that they may occasionally be recovered in the fifth or possibly the sixth week after infection.

5. This method is of greatest value in those cases where the diagnosis is doubtful and especially where the patient refuses permission to excise a piece of muscle or where the muscle findings are negative.

[1] Demonstration of the Trichinella Spiralis in the Circulating Blood in Man, Archives of Int. Med., 1909, III, 203.

[2] Klinische u. exper. Untersuchungen über Trichinosis, Verhandl. des Kongress f. klin. Med. Wiesbaden, 1905, p. 354; Beitrag zum Nachweis von Parasiten im Blut, Münch. med. Woch., 1908, LV, 2601; Trichinosis, Wiesbaden, 1909, Verlag von J. F. Bergmann.

[3] Verhandl. des Kongress f. klin. Med. Wiesbaden, 1905, p. 354 Münch. med. Woch., 1908, LV, 2601.

[4] Trichinosis, Wiesbaden, 1909, Verlag von J. F. Bergmann.

[5] Loc cit.

Digitized by Google

[6] Trichinella Spiralis in Human Blood, Jour. Amer. Med. Assoc., 1910, II, 54, p. 1297.

[7] A case of Trichinosis with Recovery of Parasite from the Blood and Muscle, Archives of Int. Med., 1910, V. 530.

[8] A Case of Trichinosis; Trichinella Found in Blood Taken from an Ordinary Ear Puncture, Archives of Int. Med., 1910, VI, 301.

[9] Trichinosis, Wiesbaden, 1909, Verlag von J. F. Bergmann.

[10] Die Tierischen Parasiten des Menschen, Wurzburg, Verlag von A. Stuber, 1908.

Since the above was written embryos have been recovered in three additional cases of Trichiniasis.

Digitized by Google

IX.

A CLINICAL STUDY OF THE THERAPEUTIC VALUE OF THE CALCIUM SALTS IN GASTRIC TETANY, WITH AN ANATOMICAL REPORT ON THE PARATHYROID BODIES.*

By Francis P. Kinnicutt, M.D., Visiting Physician.

Recent researches tend to show that there is an intimate relation between the various forms of tetany and an insufficiency of the parathyroid glands; they also strongly suggest that there is an equally direct and intimate relation between disturbances of the calcium contents of the tissues of the body and tetany; and, finally, that the secretion of the parathyroid bodies exerts in an as yet imperfectly understood way a controlling influence upon calcium metabolism. Numerous researches have shown the moderating effect of the calcium salts upon the hyperexcitability of the central nervous system, and the recent noteworthy study by MacCallum and Voetglin[1] has demonstrated the controlling influence of these salts upon the spasm of experimental tetany. The results observed by them have suggested the probable therapeutic value of the calcium salts in the various forms of human tetany.

Recently an opportunity has been afforded in the Presbyterian Hospital for a study of the effect of the calcium salts

*Read at a meeting of the Association of American Physicians, Washington, D. C., May 11 and 12, 1909.

(*Reprinted from the American Journal of the Medical Sciences, July*, 1909.)

Digitized by Google

in a case of gastric tetany, and of the parathyroid bodies after death. The case is of much interest in view of the rarity of that form of gastric tetany associated with dilatation of the stomach and stagnation of its contents, of which it is an example; in the severity of the tetanic symptoms; in the prompt inhibitory effect upon the spasms of the calcium salts artificially introduced directly into the blood stream; and, finally, in the findings at autopsy.

A male, aged thirty-three years, was received in my wards in the Presbyterian Hospital on October 25, with the diagnosis of gastric tetany by my interne, Doctor Vaughan, a diagnosis fully confirmed on examination of the patient. The family and personal histories, briefly, are as follows: Both parents died of pulmonary tuberculosis. The patient at times has been a heavy drinker, and especially has been a large consumer of beer. There is a history of gastric symptoms from early in 1905, at which time he was admitted to Bellevue Hospital suffering apparently from an acute gastritis of alcoholic origin; he was discharged relieved of his symptoms. A year later he was again admitted on account of a severe gastric hemorrhage following a drinking bout. A diagnosis of duodenal ulcer was made. On discharge from the hospital, and up to the date of the illness for which he was admitted to the Presbyterian Hospital, he suffered from much epigastric distress, flatulence, and frequent vomiting. He states that occasionally as much as "a gallon of green fluid" was vomited, but at no time any blood. The night before admission to my wards the patient states that he drank copiously of aërated water, nothing alcoholic. He went to bed feeling well, slept, but awoke several hours later with severe cramps in the legs and arms. He was unable to move them, but felt no pain beyond a drawn and tense feeling in the cramped muscles. He called for assistance with difficulty, as his tongue and jaws were stiff. His abdomen was distended, and he vomited several times. He sweated profusely. He was very restless. Later his affected muscles became tender and were painful. The cramps and stiffness in no way relaxed up to the time of admission.

Examination on Admission. Patient is poorly nourished; looks ill. Is unable to speak intelligibly. Is extremely restless. Temperature (rectal), 101°. Pulse, 100 and of poor quality, regular in rhythm. Blood pressure, systolic, 112 mm. Respirations, 80. The attention is at once attracted to the abdomen and to the presence of tetanic symptoms. The contour of a dilated and distended stomach is easily appreciable. The lower outline reaches a point 10 cm. below the umbilicus in the median line, and to the right the distention reaches well beyond the parasternal line. Succussion sounds can be produced

Digitized by Google

readily over the whole of the distended area. Both legs are held straight and stiff, the feet in extreme extension, the toes in plantar flexion. The muscles of the calf of legs are hard, tense and drawn. The spasm is continuous, but pressure on the nerve trunks and bloodvessels increases, if possible, the severity of the spasm (Trousseaus sign), and the same phenomenon obtains on tapping over the motor nerves supplying the affected muscles (Chvostek's sign). The forearms are flexed at a right angle on the arms, the wrists flexed to an extreme degree and cannot be extended, the fingers flexed at right angles at the metacarpophalangeal articulations and held rigidly straight in adduction, the thumb tightly against index finger—not drawn into palm. The spasms are continuous, but, as in the case of the lower extremities, they can be increased both by Trousseau's and Chvostek's methods. The tendon reflexes appear to be about normal in both upper and lower extremities. There are continuous twitchings of the muscles of the face, which are increased by tapping over the course of the motor trunks. A slight degree of trismus is present. The musculature of the trunk is free from spasm, and it cannot be excited by mechanical irritation of the motor nerves or the muscles. The tachypnœa is striking, the respirations, as previously stated, being 80.

The stomach was at once washed out and a large quantity of greenish ill-smelling fluid was recovered. A few hours subsequent to the lavage the spasms of the upper extremities were entirely relieved, but there was no intermission in those of the lower.

October 26. The spasms of the upper extremities are again present and are continuous, and there has been no intermission in those of the lower extremities. In spite of lavage twice used in the past twenty-four hours the patient has vomited several times, 80 ounces in all the vomited matter a greenish fluid. The patient has not voided urine since admission, and catheterization recovered only 6 ounces of urine, of specific gravity 1016, containing a trace of albumin, no glucose, a trace of indican, and a few hyaline and granular casts. Subcutaneous clyses, 1000 c.c. of a normal salt solution, were ordered to relieve, if possible, the evident dehydration of the body tissues. The temperature fell gradually during the day to 97.5° at midnight; the respirations to 20 to 24. Blood examination: Red cells, 4,910,000; white cells, 13,500; hemoglobin, 75 per cent.; color index, 0.7; polymorphonuclears, 89 per cent.; large and small lymphocytes, 9.3 per cent.; transitionals, 1.7 per cent.

October 27. There has been no appreciable diminution in the spasms of the extremities, which are still continuous. In addition to lavage and subcutaneous clyses, one-half grain of a parathyroid extract, furnished by Dr. Beebe, was directed to be given three times daily by the mouth, and caffeine as a heart stimulant. The temperature has been subnormal throughout the day. In view of the pulmonary signs present, von Pirquet's tuberculin test was tried, with negative results.

October 28 (A. M.). The patient was extremely restless and irrational in the early part of the night, but after lavage and a subcutaneous clysis of 2000 c.c. of salt solution, slept quietly, with a partial relief of the spasms of the

Digitized by Google

upper extremities, but with continued extensor spasm of the muscles of the legs. During the day the spasms in the upper extremities have again been present, and there has been no intermission in those of the lower extremities. Patient very restless and irrational. In addition to the parathyroid extract, 2 grams of calcium lactate in 1200 c.c. of normal salt solution was directed to be given intravenously. The immediate effect was to quiet the great restlessness of the patient, and a few hours later there was a marked diminution in the degree of spasm in the upper extremities, and for the first time since admission, in the lower extremities. The temperature rose slightly to 100° before the use of the calcium salt, and did not rise above this after its administration. Pulse 80 to 96; respirations, 20 to 24.

October 29 (A. M.) The patient slept quietly the greater portion of the night. There is no spasm of the upper extremities and only slight spasm (extensor) of the legs. The electrical reactions were tested for the first time and were not found to be increased. (P. M.) Four grams of calcium lactate in 1300 c.c. of normal salt solution was given intravenously. The patient fell asleep during its administration, and for the first time since admission he became entirely relaxed. Temperature, 99.5° to 100.5°; respirations, 20.

October 30. The patient slept quietly during the night. The upper extremities are free from spasm. Late in the day slight spasm of the extensor muscles of the legs was noted. Tapping over the branches of the facial nerve still elicits slight spasm in the muscles of its distribution. This can be produced only after several moments of mechanical irritation, in marked contrast to the almost instantaneous response obtained before the first administration of the calcium salt. Four grams of calcium lactate in 1000 c.c. of normal salt solution was again given intravenously in the late afternoon. Temperature, normal. Pulse, 80 to 84; respirations, 20.

October 31. The patient slept quietly with an entire absence of spasm. Both upper and lower extremities are free from spasm, but there is slight rhythmic movement of the forearms, about 60 times a minute. The patient's mind is quite clear for the first time, and he takes an interest in all that is done for him and asks intelligent questions in regard to its purpose. The pulse has ranged from 82 to 96. The temperature (rectal) has been normal. Respirations, 20 to 24. White cells, 9900. Calcium lactate in 1000 c.c. normal salt solution was given.

November 1. The rhythmic movements of the forearms have disappeared. Spasm is entirely absent in the lower extremities. Upper extremities: From time to time the hand is momentarily flexed on forearm at intervals of about five seconds. Mechanical irritation of the nerve trunks does not increase this phenomenon. The calcium salt was omitted and a nucleoproteid preparation of the parathyroid, furnished by Dr. Beebe, was injected deep into the gluteal region twice in the twenty-four hours. Pulse, 89 to 95 during day. Temperature, slightly subnormal. Respirations, 20 to 24.

November 2. The patient slept quietly during the night. The spasms of the muscles of the forearms have increased and there is very considerable

Digitized by Google

tremor of the hands. There is also some tremor of the muscles of the chin. Pulse, 84 to 96. Temperature, subnormal during the day. Respirations, 20 to 24. In view of the increase in the spasms, in addition to the parathyroid preparation, 4 grams of calcium lactate in 1000 c.c. of normal salt solution was again given intravenously.

November 3. The patient is entirely relaxed and no spasm can be elicited by mechanical irritation of the nerve trunks in either upper or lower extremities or in the muscles of the face. Considerable tremor of the hands is present, however. The patient's general condition is not as good. Hiccough is present. The pulse is of poor force, 80 to 100 during the day. Temperature, subnormal. Respirations, 20. Four grains of calcium lactate in salt solution was given intravenously. From this date the calcium salts were discontinued and no other medication was used. There was no further spontaneous spasm, and it could not be excited by mechanical means. The patient's mind remained entirely clear, he was interested in measures taken for his relief, and was able partially to sit up in bed. There was little or no change in the temperature, pulse, and respirations from those last noted. Three days later, without the occurrence of other symptoms, the heart rather suddenly failed, and death followed speedily.

That portion of the clinical history which especially relates to the tetanic symptoms and to the effect secured by the administration of the calcium salts has been selected for detailed report. Other portions of the history will be given only in outline.

It was found impossible to nourish the patient by means of the stomach. Vomiting was frequent on each attempt, in spite of copious and frequent lavage. Nutriment introduced after lavage by means of the stomach tube, although sometimes retained, was recovered later by the tube in like amounts, showing no signs of gastric digestion—only decomposition processes. Nutrient enemas were only exceptionally retained. There was almost complete anuria for the first twenty-four hours and until abundant subcutaneous clyses of salt solution had been given. Later, the urine either was voided involuntarily or was recovered by catheterization. The scanty fluid stools were mostly involuntary.

Although the tetanic symptoms obviously could be controlled by the continued administration of the calcium salts, it was equally apparent that the patient would slowly die of inanition unless the evident gastric stenosis could be relieved by operation. In consultation, however, my late colleague, Dr. McCosh, decided against surgical intervention, on the ground that any operation would be immediately fatal.

Autopsy, sixteen hours postmortem, by Dr. Opie. The body is that of an emaciated man 160 cm. in length. Over the inner surface of the left elbow and on the right arm there are ecchymoses. The subcutaneous fat is present in very small amount, and has a deep yellow color. The peritoneal cavity contains no accumulation of fluid; fat has almost wholly disappeared from omentum. The greater curvature of the stomach is 16 cm. below the ensiform cartilage in median line. The stomach extends 9 cm. to the right of the mid-

Digitized by Google

line, and is in contact with the ribs on the left side. The lesser curvature of the stomach in the midline is 6 cm. below the ensiform cartilage. The spleen is firmly adherent to the lateral abdominal wall. The stomach has fallen considerably, and above the lesser curvature the entire head and greater part of the pancreas is visible. The lungs are emphysematous and meet in the median line; a few adhesions bind each apex to the chest wall. The pericardial cavity contains about 10 c.c. of clear fluid. The appendix arises from the inner surface of the cecum, passes inward, and lies with the tip over the pelvic brim. It is possible to pass one finger with difficulty through the foramen of Winslow.

The stomach measures 25 cm. transversely and 8.5 cm. vertically at the cardiac end. Pyloric half is almost tubular and is 5 cm. in diameter. On opening the stomach it was found to contain several hundred c.c. of bright yellow fluid, from which a sediment settles. Adherent to the mucosa is mucus. The mucous membrane is thickened, the rugæ are prominent, and the surface has a homogeneous, deep red color. The wall of the stomach is thickened by hypertrophy of its muscular layer to about 4 mm. The duodenum immeditaely beyond the pylorus is bent backward and held in contact with the stomach by adhesions for a distance of about 1 cm. Gentle separation of tle adhesions exposes a perforation, from which gastric contents escape. It is found impossible to pass a finger from the stomach through the pylorus into the duodenum, obstruction being in a large part due to the bend just described. Immediately below the pylorus in the mucous membrane of the duodenum there is a depressed scar, 0.25 x 1 cm., partially encircling the duodenum. At the upper angle of this area is a deeper ulceration in diameter not more than 7 mm.; the surface here is black and eroded, and the partial perforation mentioned above allows the passage of a small probe. There is thick fibrous tissue immediately about the ulcer, but no marked induration. The duodenum is somewhat injected, but otherwise normal. The pancreas is normal. The heart weighs 255 grams. The organ is small; the muscle is firm and brownish in color. The aortic valve is normal; there is slight thickening of the free edge of the mitral valve; there are several minute nodular projections. The pulmonary and tricuspid valves are normal. The coronary arteries are smooth.

The left lung is voluminous, and abundant fluid escapes from the cut surface. Throughout a large part of the upper lobe is scattered gray nodules partly caseous; there are several larger nodules 1.5 cm. across, and cavity formation has occurred in the centre of a caseous area. Right lung is much more voluminous than the left; tubercles are much more numerous in the upper lobe, and there occur several small cavities similar to the cavity in the left lung; it is in direct communication with a bronchus. The uppermost 2 cm. of the apex is almost entirely consolidated by tuberculous nodules. The lower lobe contains sparsely scattered tubercles; in large part it is firm and is partially consolidated by scattered areas of homogeneous, deep red color, though nowhere is it entirely airless. The liver weighs 1450 grams. The organ is firm and deep red; the mottling is indistinct. Gall-bladder is contracted and contains a small amount of viscid bile. The spleen is not enlarged;

Digitized by Google

it measures 11 x 7.5 x 4.5 cm. It is very firm, and has a homogeneous, deep red color; the Malpighian bodies not well seen. The kidneys weigh 310 grams together. They resemble each other closely; the capsule is removed easily, leaving a red surface in which there are a few minute cysts. The cortex, which measures about 5 mm., is deep red. The glomeruli are conspicuous; the pyramids are injected. On the surface of the right kidney there is a yellow patch 0.5 cm. across (apparently aberrant adrenal tissue). Suprarenals together weigh 20 grams. They appear to be normal. The aorta is smooth save for a few slightly raised yellow patches. The urinary bladder is normal in size. Scattered over the inner surface, but chiefly on the posterior wall above the trigon, are submucous hemorrhages; in this situation are numerous minute vesicles. The rectum is deeply injected. The thyroid gland appears to be normal. The two parathyroids on either side were exposed, and as far as could be determined are normal. The small intestine in some places shows injection of the mucous membrane, most marked in the lower part of the ileum where the mucous membrane has a homogeneous, deep red color. The lumen of the appendix is patent. The large intestine throughout shows intense injection of the mucous membrane, but is otherwise negative.

Culture from the heart's blood shows a pure growth of Bacillus coli.

Microscopic Examinations. The liver tissue is much congested. The vessels of the kidney are all dilated and filled with blood. The epithelium of the tubules shows cloudy swelling; the cells are in places desquamated and the tubules are filled with debris. In the cortex there are many areas infiltrated with lymphoid cells. The bloodvessels of the lungs are everywhere congested, and in places there is serous exudate in the alveoli. There are many areas in which the alveoli are completely filled by polymorphonuclear leukocytes; there is a little fibrin. In several areas are chronic tuberculous lesions associated with newly formed fibrous tissue. The heart muscle is normal. The bloodvessels of the spleen are much congested.

Parathyroid Glands. The right and left superior parathyroid bodies were examined microscopically. They are of normal size and exhibit no abnormality. Scattered cells with affinity for eosin occur in moderate number. There is no increase of connective tissue and the bloodvessels are normal. The right inferior body likewise appears to be normal in structure and size. In the connective tissue near this parathyroid is a small round mass of tissue which resembles the much larger parathyroid body from which it is wholly isolated. The cells which compose this nodule are smaller than those of the parathyroid, and their protoplasm stains more deeply; they are, like those of the parathyroid, arranged in columns between the capillaries. About this nodule connective tissue is concentrically arranged to form an ill-defined capsule; in this tissue lymphoid cells are numerous. At a short distance from the nodule just described, and from the normal parathyroid and situated just outside the wall of a small vein, is an isolated round group of cells identical with those which make up the aberrant nodule. This group consists of about

Digitized by Google

25 small cells closely packed together. Sections made through the middle of the left inferior glandule showed that parathyroid tissue is abundant and normal. The parathyroid glands therefore, exhibit no abnormality; no evidence of hypertrophy is found. (Near one parathyroid are small aberrant nodules of tissue resembling that of the parathyroid.) The thyroid gland is normal in structure. The alveoli contain colloid in normal amount.

Studies of the Urine. Guinea-pig I. Injected with 20 c.c. of urine into peritoneal cavity. Died after twenty-four hours; some fluid in peritoneum. No exudate. Cultures sterile. Sections, see below.

Guinea-pig II. Injected with 15 c.c. of urine into peritoneal cavity. Died in thirty hours. Findings as in No. I.

Guinea-pig III. Injected with 10 c.c. of urine. Died in thirty-six hours. Findings as above. Three controls using normal urine, all recovered.

Studies of the Stomach Contents. Guinea-pig IV. Given 10 c.c. of filtered stomach contents by stomach tube; after twelve hours looked sick but recovered.

Guinea-pig V. Injected into peritoneal cavity 5 c.c. of filtered stomach contents. Died in ten hours—peritonitis. No convulsions. Cultures showed many organisms.

Guinea-pig I A. Injected 0.1 c.c. into peritoneum. Died in twelve hours. No convulsion. Anaërobic cultures of peritoneum, sterile.

Guinea-pig II A. Injected 0.2 c.c. subcutaneously. After eighteen hours it developed a paralysis of the right fore leg. Became very spastic, especially the hind legs; there was incoördination; no hyperesthesia, but stimulation of the abdomen caused clonic contractions of the limbs, which manifested itself in the jumping of the animal in a forward direction, which seemed uncontrollable. On several occasions the animal jumped so high as to strike on the top of the cage. After the spastic stage, a period of great weakness with loss of reflexes ensued, and the animal died in this stage twenty-two hours after injection.

Cultures. Aërobic: heart blood, Bacillus coli(?) spinal canal, Bacillus coli(?). Anaërobic: heart blood, Bacillus coli; spinal canal, sterile.

The abdominal parietes were very œdematous and reddened; no abscess formation; peritoneum and viscera normal. Brain and cord showed no macroscopic lesion.

Guinea-pig III A. 0.5 c.c. injected subcutaneously. This animal showed exactly the same symptoms as No. II A, except that the motor excitement stage was shorter, came on more quickly; died in twenty-one hours.

Cultures. Aëobic, as above; anaërobic, as above. Pathological findings, as above.

The microscopical sections of Guinea-pigs I, II and III revealed marked cloudy swelling of the viscera; otherwise nothing of note was found.

Digitized by Google

Filtrate of Stomach Contents (Berkefeld Filter). Injected into guinea-pig as in I A, II A and III A no apparent effect.

Cultures of the filtrate revealed a few colonies of Bacillus coli.

It is a matter of regret that an examination of the brain and cord was not allowed, as the few reports of autopsies in cases of tetany are conflicting both as regards the existence of any constant lesion of the nervous system and its form. The full anatomical report on the parathyroid bodies, by Dr. Opie, is of especial interest.

Certain facts stand out prominently in the clinical study of the case which has been related:

1. The rapid and controlling effect of the soluble calcium salts upon the tetanic symptoms.

2. The maintenance of this effect only by their continued use.

3. The comparatively slight effect of large infusions of salt solutions, used alone.

4. The slight influence, if any, of parathyroid preparations (nucleoproteid) given by the mouth in controlling the hyperexcitability of the nervous system. The effect of the nucleoproteid given subcutaneously cannot be estimated positively in the present instance, as it was given alone only during a period of twenty-four hours and when the tetanic symptoms had been controlled practically by the calcium salt. A distinct renewal of the spasm at the end of this interval led to the renewed use of the calcium salt in combination with the parathyroid material. The demonstration of the controlling influence of the soluble calcium salts upon the characteristic symptoms of at least one important variety of human spontaneous tetany—the tetany of gastrectasis, with stagnating stomach contents—suggests a probable similar therapeutic value of these salts in other forms of the disease in human beings.

Digitized by Google

5. The occurrence of typical tetanic spasm in a case of gastrectasis with parathyroid bodies of normal anatomical structure and—presumably—of normal functioning power.

The facts elicited in the clinical and pathological study of the cases add little to our positive knowledge of the pathogenesis of gastric tetany. A profound disturbance of the calcium metabolism would seem probable in the present instance. The explanation of it is difficult. There is much experimental evidence to show that the parathyroid secretion in some way controls the calcium exchange in the body, yet in the present instance the functioning power of the parathyroids presumably was normal. The generation of a poison of unknown nature in such amount as to cause a relative functional inadequacy of the parathyroid bodies can only be a matter of conjecture.

[1] On the Relation of Tetany to the Parathyroid Glands and to Calcium Metabolism, Jour. Exp. Med., 1909, XI, 118.

Digitized by Google

X.

NITROGEN AND MINERAL SALT METABOLISM IN HEALTHY INFANT FED ON MODIFIED COW'S MILK, WITH ESPECIAL REFERENCE TO RATIOS EXISTING BETWEEN NITROGEN AND THE VARIOUS MINERAL SALTS IN RELATIVELY LOW, MEDIUM AND HIGH FAT FEEDING.

By B. Raymond Hoobler, M. D., Lately Pathological Externe.

The metabolism of infants fed on breast milk has received considerable attention from the very beginning of metabolism experiments some fifteen or twenty years ago. Most of the research has been done by German and French workers. With a practical end in view a very large part of the work has been done on sick infants. According to Czerny and Keller[1] forty or fifty quite complete researches have been done on sick children, most of them on malnutrition and gastro-enteritis cases. These fields have been well worked and have yielded abundant harvests in our better understanding of these conditions.

Studies of the metabolism of infants fed on cow's milk diluted or undiluted have not been so numerous and most of those which have been done have been on abnormal children.

In the normal cases which have been studied, but a very small number have been fed on modified cow's milk, so few in fact, that the data derived from a study of them is not at all convincing as to what constitutes normal metabolism in infants fed on cow's milk.

Digitized by Google

In the early literature on this subject, there are several extensive pieces of work reported on normal infants fed on cow's milk. One by Rubner and Heubner (Blauberg),[2] another by A. Keller[3] and Cronheim and Muller[4] have contributed the results of studies in five normal cases.

There have been a great many other pieces of work done, especially covering nitrogen metabolism and a lesser number on either one or another of the various salts. From among these I have chosen for comparison those named above. The work of Rubner and Heubner[2] is by far the most complete, covering the metabolism of nitrogen, fat, carbohydrate, potassium, sodium, calcium, magnesium, iron, chlorine, sulphur, phosphorus, determining the loss by respiration and sweat as well as through urine and feces. Their work was of such a wide scope that a careful study of it with a just appreciation of the time and patience required tends to discourage one from trying to duplicate it unless unlimited time and opportunity can be given to it.

The study of the metabolism of nitrogen together with its relation to the metabolism of phosphorus, chlorine, calcium, metabolism, sulphur and its compounds and mineral ash in a healthy infant, fed on cow's milk mixtures, containing relatively low, medium and high percentages of fat constitutes the problem set for this paper.

The child used for this study was a healthy, robust, vigorous infant of nine months, fed from birth on modified cow's milk, who was admitted to the children's ward of the Presbyterian Hospital in the service of Dr. E. Eliot, for operation for the closure of hare-lip. A preliminary operation had been performed and in the interim between operations Dr. Eliot very kindly permitted the child to be used for metabolism purposes. Dr. Eugene Opie, pathologist and Drs. Cecil and DuBois, his

Digitized by Google

assistants, co-operated heartily in the undertaking, the last named devising a metabolism apparatus, through the use of which perfect results were obtained in the collection of urine and feces. To these gentlemen and their laboratory staff, I extend my thanks.

The child was fed on three different cow's milk mixtures. These involved the use of (certified) whole milk, fat free milk and 16 per cent. cream, all of which were secured from the Walker-Gordon laboratory and when modified, represented a relatively low, medium and high fat formula. Specimens of each of the three types of milk were carefully analyzed. The child was kept on a definite formula at least two days before being put in a metabolism frame and was kept three days continuously in the frame and given the same formula, so that the feedings were of five days' duration, while the metabolism experiment covered the last three days of the period. After each three-day period in the frame the child was given a rest for about ten days before being put into the frame again. This period of rest gave the child ample time to recover his normal activities before going into the frame again. I might suggest here that the putting of the child in the frame involved not the least hardship for the child; indeed, it was the universal opinion among the nurses that the child was happier in the frame than out of it.

The urine was collected daily and the total nitrogen, urea, ammonia, purin and kreatinin determinations were made the same day. The urine was then placed on ice until the salts were analyzed. The feces were collected in daily quantities except in two instances when two-day periods were collected, were dried over water bath, pulverized and passed twice through a No. 40 sieve and stored in glass containers until examined.

Digitized by Google

The methods used for the nitrogen determinations were the Kjeldahl method for total nitrogen, Folin's method for ammonia,[5] Folin's method for kreatinin,[6] Folin's method for urea,[7] Walker Hall's method for purin bases, Benedict's[8] method for total sulphur in urine, Wolf and Osterberg's[9] method for total sulphur in food and feces, Folin's[10] methods for total sulphates, and for ethereal sulphates.

Calcium and magnesium were determined by the method of McCruden.[11] Sodium chloride was found by Mohr's method, and phosphates in urine by titration with uranium nitrate, while phosphates of food and feces were determined by method in Hoppe-Seyler's[12] Zeitschrift.

FEEDING.

(See Columns 4 and 5, Tables I-VIII.)

For the aid of those who think best in terms of per cent. feeding or caloric values, let me state that the feedings were as follows:

	Fat%	Carbo.%	Proteid%	Calories per kilo.
3 days "low fat".....	2.1	8.93	4.15	109.3
3 days "medium fat".....	4.0	9.43	3.50	140.7
3 days "high fat".....	5.4	9.41	3.38	165.6
Average for 9 days.....	3.8	9.25	3.68	138.5

WEIGHT.

(See Column 3, Tables I to VIII.)

	Weight at beginning	Weight at end of exp.	gain or loss per day
3 days "low fat".....	8320.5	8278.0	14.1
Average 3 days "medium fat".....	7852.8	8164.6	81.1
3 days "high fat".....	7904.55	8164.6	42.7
9 day period.....	7852.8	8278.0	47.25

Digitized by Google

STUDY OF NITROGEN INTAKE.

(Column 6, Table I.)

	N. intake in grams, in 24 hours.	N. intake per kilo body weight, in grams in 24 hours.
3 days "low fat"	8.5078	1.05
3 days "medium fat"	7.1752	.914
3 days "high fat"	6.9358	.866
9 day period	7.5396	.943

RELATION OF INTAKE OF NITROGEN TO INTAKE OF MINERAL SALTS.

(Column 17, Tables II to VIII.)

	N:NaCl as	N:P_2O_5 as	N:S as	N:CaO as	N:MgO as	N:Ash as
3 days "low fat"	1: .272	1: .264	1: .054	1: .240	1: .012	1: 1.05
3 days "medium fat"	1: .333	1: .382	1: .060	1: .280	1: .010	1: 1.32
3 days "high fat"	1: .337	1: .322	1: .070	1: .300	1: .021	1: 1.27
9 day period	1: .311	1: .318	1: .060	1: .275	1: .014	1: 1.20

The figures given above as the averages for the nine days represent the amount of nitrogen, together with its ratio to the mineral salts in the food of an infant of nine months fed on approximately whole cow's milk, 7 ounces in six feedings, with 2 ounces of lactose added to the 24-hour amount. The child had been fed on whole milk undiluted before admission to hospital and though overfed from caloric point of view yet seemed to thrive as do many other infants whose diet is not supervised. This overfeeding, however, frequently ends disastrously.

Study of nitrogen elimination by feces:

(Column 7, Table I.)

Whether the nitrogen eliminated in the feces was a portion of the food nitrogen ingested but which was not absorbed while

Digitized by Google

passing through the intestinal tract, or whether a certain portion of it represents that excreted from the body into the intestinal canal, cannot be definitely stated. But we know that whether passing through the intestine unabsorbed or excreted from the body into the intestine, the amount which was lost from the body through the feces is represented by the following figures:

	Grams in 24 hours	Per cent. of driedfeces	Per cent. of intake	Gr. per kilo bodywt.
3 days "low fat".....	.3099	2.804	3.8	.065
3 days "medium fat"..	.3725	2.701	5.6	.048
3 days "high fat".....	.2027	2.310	2.9	.025
9 day period	.2950	2.605	4.1	.046

It will be seen that the greatest actual amount of nitrogen as well as the highest per cent. of nitrogen intake was passed in the feces during "medium fat" feeding, also that the smallest amount of nitrogen lost through the feces was during "high fat" feeding, also that the lowest amount per kilo body weight was passed under a "high fat" period and further, that when compared with the nitrogen intake, the smallest proportion of intake appeared in feces under the "high fat" period. It should be remembered that a smaller actual amount of nitrogen was ingested under the "high fat" than during other periods.

Study of ratios of nitrogen to the mineral salts in feces:

STUDY OF RATIOS OF RATIOS OF NITROGEN TO THE MINERAL SALTS IN FECES.

(Column 19, Tables II to VIII.)

	N:NaCl	N:P_2O_5	N:S	N:CaO	N:MgO	N:Ash
3 days "low fat"....	1: .135	1: 2.46	1: .166	1: 7.3	1: .018	1: 13.70
3 days "medium fat"	1: .420	1: 1.60	1: .066	1: 4.5	1: .008	1: 8.42
3 days "high fat"...	1: .297	1: 1.86	1: .094	1: 4.6	1: .003	1: 9.21
9 day period	1: .292	1: 1.96	1: .110	1: 5.5	1: .013	1: 10.4
Compared with ratios of intake; for 9 day period	1: .311	1: .318	1: .060	1: .275	1: .014	1: 1.20

Digitized by Google

Chlorine and magnesium occurred in the same ratio in feces as in food. Phosphorus and calcium occurred in feces in ratios greatly increased above the ratios in food, while the ratio of nitrogen to sulphur was twice as great in feces as in food.

Study of nitrogen absorption:

(Columns 10, 11 and 15, Table I.)

Nitrogen absorption has been found by previous observers of normal metabolism to be very well carried on. Keller's[2] Case XII showed absorption of 93.7 per cent. of food nitrogen; Rubner and Heubner's[3] case, 93.5 per cent.; Cronheim and Muller's[4] cases, 1908, four months infant, 90.0 per cent.; six months infant, 89.7 per cent.

The absorption figures in this case are:

	Absorption N. grams in 24 hours	Per cent food Nitrogen	Absorption per kilo in 24 hours
3 days "low fat".....	8.1978	96.3	.985
3 days "medium fat"....	6.8026	94.8	.866
3 days "high fat".....	6.7331	97.0	.841
9 day period	7.2445	96.0	.897

It appears from this that nitrogen absorption takes place equally well under any of the three types of feeding.

Study of absorption ratios of nitrogen to mineral salts:

(Column 21, Table II to VIII.)

STUDY OF ABSORPTION RATIOS OF NITROGEN TO MINERAL SALTS.

(Column 21, Tables II to VIII.)

	N:NaCl	N:P_2O_5	N:S	N:CaO	N:MgO	N:Ash
3 days "low fat".....	1: .277	1: .176	1: .049	1: ...	1: .012	1: .574
3 days "medium fat".	1: .328	1: .314	1: .060	1: .052	1: .007	1: .932
3 days "high fat"....	1: .338	1: .275	1: .064	1: .170	1: .009	1: 1.02
9 day period	1: .312	1: .250	1: .057	1: .059	1: .010	1: .827
Compared with ratios of intake for 9 day period	1: .311	1: .318	1: .060	1: .275	1: .014	1: 1.20

It would appear that nitrogen, chlorine, sulphur and magnesium were absorbed in the same ratios as these elements

Digitized by Google

existed in the food, the greatest variations from the ratios in the food occurred in calcium and phosphorus. In "low fat" feeding calcium was withdrawn from the body, more having been found in the feces than was present in the food. In "medium fat" feeding but little was absorbed while the best absorption of calcium occurred in "high fat" feeding, during which time 54.5 per cent. of the calcium in the food was absorbed.

Phosphorus absorption was relatively less in "low fat" feeding; was best in "medium fat" feeding where is approximated the amount in the food.

Study of nitrogen retention and its relation to the retention of mineral salts:

(Columns 12, 13, 14, 16, Table I.)

While there is a very low per cent. of the food nitrogen retained in cow's milk feeding, yet the actual amount retained compares favorably with the actual amount retained under breast feeding as shown by Orgler.[13] It would seem, however, that the ingestion of cow's milk proteid involves a large amount of chemical work for its absorption, together with additional work for the prompt elimination of that which is not to be stored. Keller's[3] Case XII retained 34.1 per cent.; Rubner and Heubner's[2] case, 23.8 per cent.; Cronheim and Muller's,[4] four months infant, 23.5 per cent.; their six months infant, 24.1 per cent.

The figures for retention as shown in this case are as follows:

	Retained N. in grams 24 hours	Per cent food Nitrogen	Retention per kilo per day
8 days "low fat".....	3.0109	35.3	.362
8 days "medium fat"....	2.1224	29.5	.270
8 days "high fat".....	2.2611	32.6	.285
9 day period	2.4648	32.5	.306

Digitized by Google

It is very evident that these figures confirm the findings of previous investigators.

Study of retention ratios of nitrogen to mineral salts:

(Column 22, Tables II to VIII.)

The ratios of retention between nitrogen and mineral salts were as follows:

STUDY OF RETENTION RATIOS OF NITROGEN TO MINERAL SALTS.
(Column 22, Tables II to VIII.)

The ratios of retention between Nitrogen and Mineral Salts were as follows:

	N :NaCl	N :P_2O_5	N :S	N :CaO	N :MgO	N :Ash
3 days "low fat".....	1: .001	1: .110	1: ...	1: ...	1: .003	1: ...
3 days "medium fat".	1: ...	1: .062	1: .071	1: ...	1: ...	1: 1.36
3 days "high fat"....	1: .065	1: .229	1: .052	1: .500	1: .002	1: 1.21
9 day period	1: .011	1: .128	1: .040	1: .160	1: .002	1: .800
Compared with ratios of intake for 9 day period	1: .311	1: .318	1: .060	1: .275	1: .014	1: 1.20

It will be noted that while the retention of nitrogen was low, the retention of the mineral salts was relatively lower. The retention was poorest on the "low fat" diet, better on "medium fat," and best, as regards amount retained, on "high fat" feeding. In no instance was nitrogen or any of the mineral salts retained in the same ratio in which they existed in the food; the sulphur salts most nearly approximating that ratio.

The foregoing figures are not presented for the purpose of drawing any definite conclusions, but rather that when compared with other similar pieces of work, they may aid in the determination of normal metabolism in healthy infants fed on cow's milk mixtures.

Digitized by Google

BIBLIOGRAPHY.

[1] Czerny u. Keller: Des Kindes Ernarung, Band I, 251.
[2] Rubner u. Huebner: Zeitschr. f. Biologie, Bd. XXXVIII, 315.
[3] Keller, A.: Archiv. f. Kinderheilkunde, Band XXIX, 1.
[4] Cronheim u. Muller: Biochem. Zeitschr., Bd. IX, 76.
[5] Folin: Zeitschr. f. physiol. Chem., 1902, XXXVI, p. 333.
[6] Folin: Zeitschr. f. physiol. Chem., 1904, XLI, p. 223.
[7] Folin: Zeitschr. f. physiol. Chem., 1901, XXXII, p. 504.
[8] Benedict: Biolog. Chem., Vol. VI, 363.
[9] Wolf u. Osterberg: Biochem. Zeitschr., Bd. XXIX, 429-438.
[10] Folin: Am. Jour. of Physiology, Vol. VIII, 1905, p. 47.
[11] McCruden: Jour. of Biolog. Chem., June, 1910.
[12] Hoppe-Seyler's: Zeitschr., Vol. XLIII, p. 32-36.
[13] Orgler: Der Eiweissstoffwechsel der Sauglings. Ergebnisse der Inneren Medizen und Kinderheilkunde, Band II.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

XI.

THE ABSORPTION OF FOOD IN TYPHOID FEVER.*

By Eugene F. DuBois, M.D., Lately Pathological Externe.

Since von Hösslin[1] published his work in 1882 dealing with the absorption of food in typhoid fever, practically no work has been done on the subject. In the meanwhile the methods of food and feces analysis have been changed and the diet of typhoid fever patients has been greatly increased. The so-called High Calory Diet is being more and more used in typhoid fever and our patients in the height of their fever, are eating more than was formerly given in the second week of convalescence. The question naturally arises as to whether the patients are absorbing the food or are passing it through the intestines undigested.

At the suggestion of Dr. Warren Coleman, the writer studied the absorption of foods in seventeen periods in four different cases of typhoid fever and in two periods on two normal individuals. The diet used was the so-called "High Calory Diet," which consists of about 1000 c.c. milk, 300-400 c.c. 20 per cent. cream, 100-200 gm. lactose, two or three eggs, a couple of slices of toast and some butter. This amounts to between two or three thousand calories. One or two thousand more calories can be given in the form of larger amounts of the above foods

To this essay was awarded the Briddon Prize Medal for 1911. See article XXXIV.

*From the Department of Applied Pharmacology, Cornell University Medical College and the Second Medical Division of Bellevue Hospital, New York City.

Digitized by Google

or in the form of boiled rice, custard, apple sauce, oatmeal gruel, Cream of Wheat, mashed potato, or ice cream. This diet has been described by Coleman[2] and Shaffer and Coleman[3] and is the only recorded diet which has succeeded in maintaining the patients in nitrogen equilibrium.

With such a diet as this one would naturally suppose that the extensive intestinal ulceration, the usual poor appetite and stomach disturbances of typhoid fever would diminish the absorption of foods greatly. It was with a good deal of surprise that the writer found the absorption nearly normal.

As shown by Hermann,[4] Fritz Voit,[5] Prausnitz,[6] and repeatedly confirmed by many other investigators, the feces of normal individuals are composed to a great extent of the secretions of the intestine and its accessory glands. The residues of ingested foods play a variable part according to the absorbability of the individual food. The feces of a starving person can contain 0.1 to 0.3 gm. of nitrogen a day,[7] and of a person on a nitrogen free diet as much as 0.5 to 0.87 gm. of nitrogen a day. Similarly, reducing bodies and ether soluble substances are passed in not inconsiderable amounts when none are taken in the food. On the question of ether soluble substances, it is perhaps well to reserve judgment, as the older methods of fat analysis in stools have been found very faulty. Kumagawa and Suto[8] and also Inaba[9] have shown that the ether extraction methods heretofore used take up considerable amounts of substances which are not true fats, soaps or fatty acids, and on the other hand leave behind 12-17 per cent. of the fatty bodies. This error applies to all work done up to the last couple of years.

The absorption of fats with low melting points is better than that of fats with high melting points. Rubner[10] found the upper limit of the absorption of butter at 350 gm. a day.

Digitized by Google

(It may be noted that one of the typhoid patients in this series was given as high as 327 gm. a day.) The absorption limit for bacon is considerably lower than that of butter. In considering the absorption of fat, one can get a false idea, if one considers either the grams of fat in the stool alone, or the per cent. of unabsorbed fat alone. This is on account of the fact that on diets of less than 5 gms. fat, the feces may contain more ether extract than the food. This is shown in a series of experiments by van Noorden[11] on the same individual.

4.2 gm. Fat in Food = 57.1 % loss in Feces.
42.2 " " " " = 10.9 " " " "
80.2 " " " " = 6.36 " " " "

It is hard to state the normal percentage of loss. Schmidt and Strasburger[12] using their diet, which contains on an average 111 gm. fat, found a loss of about 5.5 per cent. Rubner giving 214 gm. butter found a loss of 2.7 per cent.; with 350 gm. butter and bacon, the loss jumped to 12.7 per cent.

In regard to protein, we are even more at a loss than in regard to fat. Our methods of analysis simply give us the nitrogen of the feces and this we multiply by 6.25 and call arbitrarily protein. With diets which contain indigestible food, such as coarse bread, tough meat, overcooked meat, etc., an appreciable part of the feces nitrogen may be food residue. On a diet of easily digested food, it is questionable if there is any protein residue. The nitrogen is found in the intestinal secretions which vary in amount with the character of the food, some foods causing much more secretion than others. Diarrhoea does not necessarily increase the nitrogen in the stools, but in such diseases as tuberculosis, or cancer of the intestine, there is a considerable increase in the fecal nitrogen. The normal amount of nitrogen in the feces averages 1 gm. a day, but can vary between 0.5 and 2.0 gm.

Digitized by Google

Sugars are completely absorbed and well cooked starches are almost completely absorbed. If carbohydrate food be coarse in quality, or poorly cooked, or eaten in unusual amounts, it is poorly absorbed. Feces as a rule contain reducing bodies which are not sugars and therefore if the normal reduction tests show small amounts of what is apparently sugar, it does not necessarily mean that the sugar is present.

Von Hösslin[1] in 1882 attempted to find out if the absorption of foods in typhoid was abnormal. He fed his patients, most of whom had diarrhoea, with various diets, such as ham, or milk, or pressed meat juice, or eggs. With diets containing from 50 to 135 gm. fat, the fat in the feces was from 5 to 10 gm., or from 6-10 per cent. The nitrogen of the food varied between 10 and 21 gm., and the feces nitrogen, from 0.9 to 2.2, or from 7.6 to 13 per cent. The carbohydrates of the food were not determined directly. Some of his patients were put on very low diets, containing only 1 to 3 gm. fat, 8 to 11 gm. carbohydrate and no protein. The ether extract of the feces was between 0.8 and 5 gm. per day, the nitrogen, between 0.4 and 0.8 gm.

The four cases of typhoid studied by the writer were unselected cases from Dr. Coleman's wards of Bellevue Hospital. It so happened that none of the cases had diarrhoea at time of experiment. In looking over the charts of about a hundred cases on the High Calory Diet, it was rather a striking fact that few cases able to take diet in large amounts have had diarrhoea. Many cases which had diarrhoea for the first few days in the hospital began to have normal stools soon after they had been on the diet.

After a patient had been in the hospital long enough to become accustomed to the diet, he was given powdered charcoal in the morning and all food taken after the charcoal carefully

Digitized by Google

recorded by a nurse, who had had two years' training in the High Calory Diet and had helped in many previous metabolism experiments. Samples of the milk and cream were analyzed from time to time. The other foods were prepared according to carefully controlled recipes and the food values calculated from the tables of Atwater and Bryant.[13] Every morning the nurse gave an enema containing 0.75 gm. soap, which amount was naturally subtracted from the amount found by analysis in the resulting stool. Excepting on one occasion, the resulting stools were surprisingly uniform. As soon as the charcoal appeared, the stools were saved, dried at a temperature below 100 C., with the addition of alcohol and analyzed in three day periods. In all cases at least two consecutive periods were made, so that the danger in irregularity in the size of the stools would be minimized. In the case of Charles N., the second and third periods were rejected, as the feces were heated above 100° C. After the experiment on the case was ended, another charcoal powder was given, and the first stools showing charcoal rejected. The division of periods by the charcoal was not very satisfactory, as the stool was necessarily mixed up by the enema. The chief reliance was placed on having many consecutive periods, and in one or two cases the final charcoal was omitted and the feces collection stopped the second day after the food period ended. The urine was collected in twenty-four hour periods, and on the few days when there was any doubt at all as to the completeness, the specimen was rejected.

The nitrogen of the urine and feces was determined by the Kjeldahl method, the total fatty bodies, by the Kumagawa and Suto method (8 and 9), and the carbohydrates by the Allihn and Pavy methods. Duplicate analyses were made in every case. A good deal of work was required to check up the relia-

Digitized by Google

bility of these methods and the results are given in the Appendix.

Description of cases.

John N., 28 years, admitted October 25.

Hist. Onset Oct. 18 with headache. Since then, anorexia and diarrhœa.

Px. Large frame, fairly well nourished, face flushed, abdomen flat, slight tenderness in left upper quadrant. A few rose spots.

Oct. 26. Blood culture shows typhoid bacilli.

Oct. 28-29. Slight soreness in abdomen, slight tympanites.

Oct. 25-No. 1. Temp. 101-104. Calories 2500-3500.

Nov. 2-8. Temp. 100-103.6. Calories 3600. Nov. 9-12, Temp. 102-105. Nov. 12, Period started, Nov. 17-20, Temp. falling. Pt. more comfortable. Nov. 21, Temp. shot up to 105. Cough developed. Nov. 27, Boggy edema of left leg. Temp. 105. Nov. 29, Signs of consolidation in left upper lobe. Leg still swollen. Patient very sick. Dec. 1, Died.

Michael K., 23 years old, admitted October 13.

Hist. One week before admission began to feel chilly and feverish. Anorexia.

Px. Fairly well nourished young man. Wt. 130 lbs. Apathetic, marked tympanites, rose spots.

Oct. 13-18. Temp. 101-104. Blood culture shows typhoid bacilli. Appetite fair. 2000 to 2500 calories a day. No distention. Oct. 18, Period started. Nov. 4, Temp. normal. Rapid convalescence.

Philip R., 23 years old, admitted Oct. 19.

Hist. For about three weeks has felt chilly and feverish. Headache severe, 4-5 watery stools daily. Took to bed October 13.

Phys. Ex. Fairly well nourished, pale, torpid, looks toxic, pulse small. Many rose spots. Temp. 102-105.

Oct. 20. Period started.

Oct. 24. Pulse stronger, few râles at bases of lungs. Abdomen not distended.

Oct. 25. Pulse not so strong. Strychnine. Slight tympanites.

Oct. 29-Nov. 3. Temp. dropping to normal. Feels better. Wt. 120 lbs.

Nov. 4-8. Temp. rising in steps to 105. Pulse weaker. Nov. 9-12, temp. 102-105.

Nov. 12. Second period started.

Nov. 19. Temp. normal. Wt. 108 lbs. Slow convalescence.

Charles N., 60 years old, admitted Sept. 23.

Hist. Has been nursing three typhoid fever cases in his family. For about four weeks has been apathetic and at times dizzy.

Phys. Ex. Well nourished elderly man, blind in right eye, spleen palpable, pulse dicrotic, several rose spots.

Digitized by Google

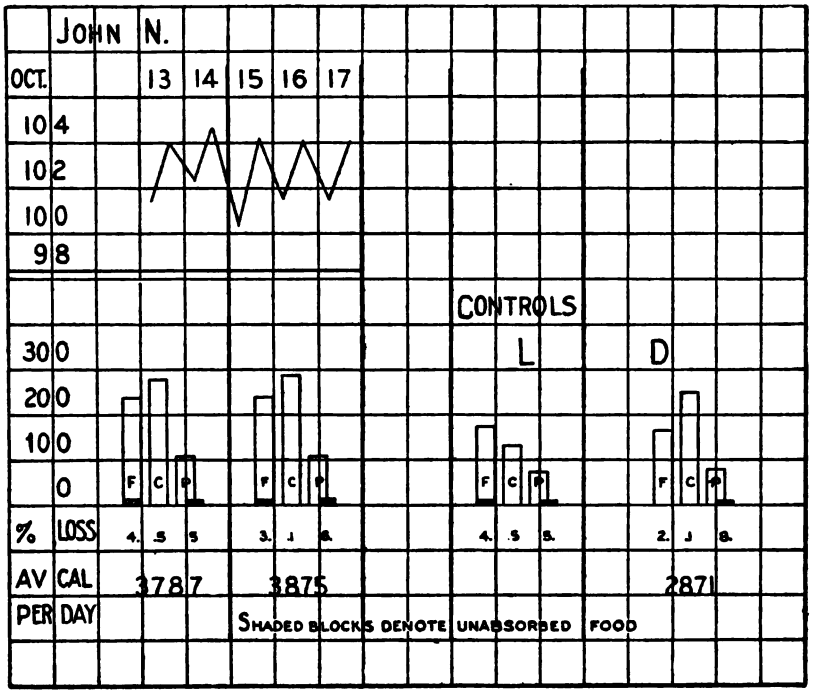
Sept. 23-Oct. 2. Temp. 101-103, appetite good, takes 3000 to 4000 calories a day. No tympanites, mind clear. Widal negative. Oct. 2, period began. Oct. 18, severe pain in head. Oct. 21, right eye painful and swollen. Diag. Metastatic choroiditis. Oct. 24, eye discharging pus. Typhoid bacillus obtained in pure culture. Oct. 27, eye much improved. Oct. 29, temp. normal. Uninterrupted convalescence.

NOTE. Reports on two more cases of typhoid fever are included in an article appearing in the *Arch. Int. Med.*, 1912. X 177. The results correspond closely with those described in this paper.

Controls.

These were two normal males, weighing about 170 lbs. and between 25 and 30 years of age.

See charts and tables.



Digitized by Google

JOHN N. DAILY AVERAGES

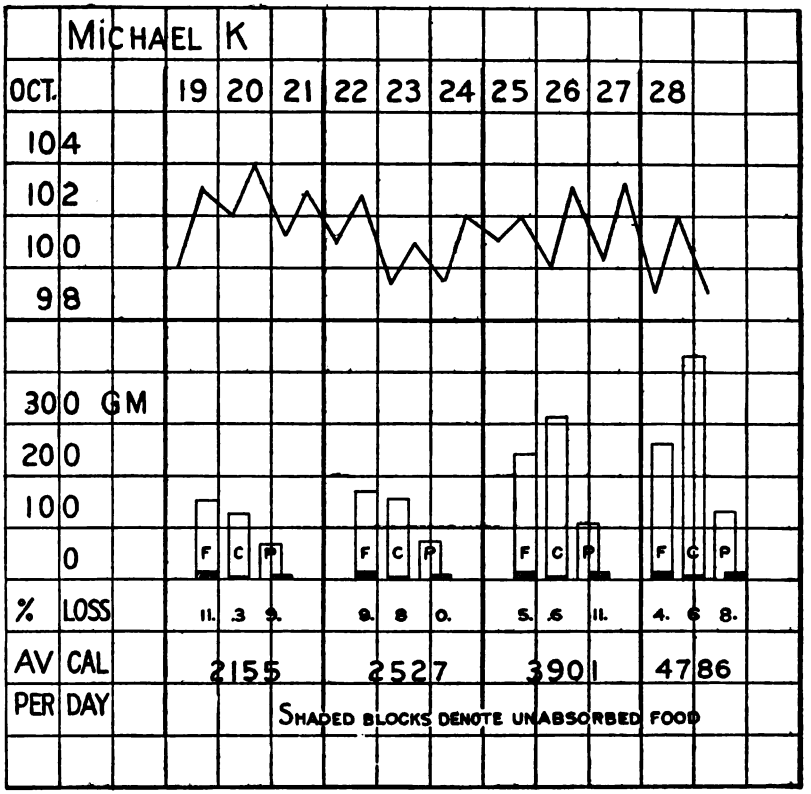
DATE	FAT			CARBOHYDRATES			NITROGEN			
OCT.	GM IN FOOD	GM IN FECES	% LOSS	GM IN FOOD	GM IN FECES	% LOSS	GM IN FOOD	GM IN FECES	% FOOD N. IN FECES	N. BALANCE GM
13-14	236.	9.8	4.2	278.	.75	0.3	17.	.91	5.	-3.9
15-17	237.	8.4	3.5	292.	.78	0.3	17.	1.03	6.	-0.5
CONTROLS										
"L"	172.	6.4	3.8	127.	.65	0.5	11.6	.57	5.	-3.8
"D"	164.	3.1	2.0	249.	.25	0.1	12.7	1.00	7.8	+0.1

Digitized by Google

MICHAEL K DAILY AVERAGES

DATE	FAT			CARBOHYDRATES			NITROGEN			
OCT.	GM. IN FOOD	GM. IN FECES	% LOSS	GM. IN FOOD	GM. IN FECES	% LOSS	GM. IN FOOD	GM. IN FECES	% FOOD N. IN FECES	N. BALANCE GM.
19-21	148.	16.6	11.2	121.	0.4	0.3	10.5	.92	8.8	-2.6
22-24	169.	16.2	9.5	154.	12	0.8	11.9	1.20	10.	-8.5
25-27	238.	11.7	4.9	309.	2.4	0.6	16.3	1.79	11.	+0.5
-28	257.	11.4	4.4	427.	2.8	0.6	20.2	1.61	8.	+2.6

Digitized by Google



Digitized by Google

Digitized by Google

Digitized by Google

PHILIP R DAILY AVERAGES

DATE	FAT			CARBOHYDRATES			NITROGEN			
	GM IN FOOD	GM IN FECES	% LOSS	GM IN FOOD	GM IN FECES	% LOSS	GM IN FOOD	GM IN FECES	% FOOD N. IN FECES	N. BALANCE GM
OCT.										
21-23	173	14.5	8.4	138.	0.4	.28	12.6	0.68	5.4	-4.2
24-28	215	11.7	5.5	198.	0.4	.20	16.1	0.78	4.8	-1.4
NOV.										
13-14	150	6.5	4.3	194.	0.4	.23	14.6	0.86	5.9	+3.2
15-17	151	6.3	4.2	266.	0.6	.23	16.7	0.92	5.5	+4.2

Digitized by Google

CHARLES N. DAILY AVERAGES

DATE	FAT			CARBOHYDRATES			NITROGEN			
OCT.	GM. IN FOOD	GM. IN FECES	% LOSS	GM IN FOOD	GM IN FECES	% LOSS	GM IN FOOD	GM IN FECES	% FOOD N. IN FECES	N. BALANCE GM
2-4	247	24.3	9.8	296.	1.2	0.4	15.2	1.06	7.0	+ 2.1
11-13	281.	19.4	6.8	222.	1.0	0.4	19.2	1.44	7.5	+ 6.9
14-16	258.	25.1	9.7	242.	1.0	0.4	18.4	1.44	7.8	+ 5.3
17-19	289.	14.9	5.2	255.	.8	0.3	18.8	1.22	6.5	+ 5.9
20-22	317.	19.6	6.1	241.	1.1	0.4	19.5	1.00	5.1	+ 6.4
23-25	300.	16.9	5.6	269.	1.2	0.4	20.0	1.78	8.9	+ 6.1
26-28	301.	14.8	4.9	249.	1.1	0.4	21.5	1.37	6.4	+10.4

Digitized by Google

Digitized by Google

Digitized by Google

SUMMARY. It will be noted that the two normal individuals used as controls showed unusually good fat absorption, as compared with normal individuals, studied by other observers. They lost only 2 and 3.8 per cent. of the ingested fat. This may be partly accounted for by the different method of fat analysis. They were not given as much fat as the typhoid cases and so the percentages of loss were not strictly comparable. The typhoid cases studied early in the disease lost from 7 to 11 per cent. of the fat taken in the food. Later in the disease, the losses amounted to 4 or 5 per cent.

Carbohydrates were almost as completely absorbed in the typhoid patients as in the controls. The feces nitrogen never rose above 1.8 gm. a day and often was below 1 gm. These figures do not show enough variation from the normal to be of any significance.

CONCLUSIONS. Typhoid fever patients can absorb carbohydrates and proteins in large amounts as well as normal individuals can. Early in the disease the absorption of large amounts of fat does not seem to be quite as complete as in normal individuals. Late in the disease, enormous amounts of fat can be absorbed.

APPENDIX.

Methods and Tables. Drying of feces. The feces was dried at a temperature below 100 C. with the addition of alcohol. It has been shown that there may be as much as 10 per cent. loss of fats in drying meat, unless the fats be first saponified by the addition of strong alkali. This would have made the nitrogen and carbohydrate analyses inaccurate. Acid was not added for fear of increasing the loss of fats. It is a general belief that nitrogen will be lost if acid be not added while drying. To test this a normal person was put on the same diet as the typhoid

Digitized by Google

patients, and one of the resulting stools analyzed while fresh and also after drying. The results are as follows:

Moist Stool.	Dried Stool.
.829% N.	.822% N.
.874	.827
.860	.828
Av. .854	Av. .826

This loss was so small that it was disregarded.

Fats were analyzed by the complicated but exact method of Kumagawa and Suto (8 and 9), which determines the fats, fatty acids and soaps together. Results obtained by this method are usually higher than by the older methods of ether extraction.

The carbohydrate determinations gave a great deal of trouble. It is impossible to make an accurate sugar test without decolorizing the feces and many of the methods of decolorization remove sugar as well as color. To test this, repeated analyses were made of 4.0 gm. samples of a specimen of dried feces; 0.25 gm. of powdered dextrose being added to each sample. It was known how much carbohydrate the sample contained before the addition of the dextrose and therefore it was known just what the result of the final analysis should be. The sugar determinations were made according to Allihn and according to the Kumagawa and Suto[14] modification of the Pavy method.

Decolorization.	Sugar Method.	Average Error.	Limits.
Bichloride	Allihn	+ 6%	+ 9.5 to + 2.6
Bichloride	Pavy	— 9	— 11.5 to — 7.0
Mercuric Nitrate	Allihn	+ 4.5	+ 5.4 to + 3.6
Mercuric Nitrate	Pavy	— 8.2	— 10.5 to — 5.9
Basic Lead Acetate	Allihn	— 6.5	— 7.2 to — 5.8
Basic Lead Acetate	Pavy	— 11.7	— 15.6 to — 7.9
Acid Charcoal	Allihn	— 1.	— 10.8 to + 5.2*
Acid Charcoal	Pavy	— 8.	— 10.9 to — 5.1

*Five tests.

Digitized by Google

The mercuric nitrate method was that described by Patein and Dufau.[15] The charcoal used was the best quality C. P. animal charcoal, made by Schuschardt and was used in the smallest possible amounts. As a result of the above tests, the charcoal decolorization and Allihn methods were selected, though a few Pavy determinations were used. The results given in all the tables are those obtained after the feces had been hydrolized by boiling one and one-half hours in 2 per cent H Cl. to convert the starch into sugar. All the samples were tested for soluble sugar after boiling with plain water. The merest traces of reduction were obtained. It is an interesting fact that the feces of Michael K., who for his first two periods took no carbohydrate except lactose, gave 0.4 and 1.2 gm. "Carbohydrate" after hydrolizing, but not after plain boiling. Some other reducing bodies must give this misleading result.

Urine and feces nitrogen were determined by the Kjeldahl method.

REFERENCES.

[1] von Hösslin: Virchow Arch. f. path. Anat., 1882, LXXXIX, p. 95
[2] Coleman: Jour. of A. M. A., 1909, LIII, p. 1145.
[3] Shaffer and Coleman: Arch. Int. Med., 1909, Vol. 4, p. 538.
[4] Hermann: Pflügers Archiv., 1890, XLVI, 93.
[5] F. Voit: Zeit. f. Biol., 1892, XXIX, 325.
[6] Prausnitz: Zeit. f. Biol., 1897, XXXV, 335.
[7] Schmidt and Strasburger: "Die Fäzes des Menschen," Berlin, 1910, p. 16.
[8] Kumagawa and Suto: Biochem. Zeit., 1908, VIII, 212.
[9] Inaba: Biochem. Zeit., 1908, VIII, 348.
[10] Rubner: Zeit. f. Biol., 1879, XV, 177.
[11] v. Noorden: Lehrb. der. Path. des Stoffwechsels, Berlin, 1893. P. 33.
[12] Cited above ([7]), p. 171.
[13] Reports of Storrs Agricultural Ex. Station, 1899, p. 113.
[14] Kumagawa and Suto: Salkowski's Festschrift, Berlin, 1904, p. 211.
[15] Patein and Dufau; Abderhalden, Handbuch des Biochem., Arbeitsmethoden, Vol. II, p. 183.

Digitized by Google

Digitized by Google

XII.

THE CAMMIDGE REACTION IN DISEASES OF THE PANCREAS.*

By Francis P. Kinnicutt, M.D., Visiting Physician.

The "pancreatic test or reaction," as is well known, is based upon Cammidge's[1] studies of the urine in disease of the pancreas. The studies indicate, Cammidge believes, that in inflammatory lesions of this organ there is excreted by the kidneys a substance which, on hydrolysis, yields a body giving the reactions of a pentose, and that such a substance is, as a rule, not found in lesions of other organs. The pentosazone precipitate which he obtains by a somewhat elaborate, though easily mastered, technique, consists of golden yellow crystals, exceedingly fine and hairlike in form, arranged in sheaves and rosettes. They are to be distinguished from glucosazone crystals by their appearance under the microscope, their ready solubility in 33 per cent. sulphuric acid and their melting point—about 160° C. To them Cammidge has given the name of "pancreatic reaction crystals," and he believes that their presence in the urine, i. e., a positive "pancreatic reaction," is "strongly suggestive of inflammatory disease of the pancreas." During the past 15 months Cammidge's pancreatic test has been applied in all cases of suspected pancreatic disease, of cholelithiasis, of

*Read at a meeting of the Surgical Section of the New York Academy of Medicine, March 5, 1909, Discussion on Acute and Chronic Pancreatitis.

(*Reprinted from the Medical Record*, 1909, p. 589.)

Digitized by Google

cholecystitis, and of diabetes, admitted to my wards in the Presbyterian Hospital. A table has been prepared giving the results obtained in all cases in the hospital in which the test has been employed. It includes a number of miscellaneous diseases and the findings in a few urinary specimens from individuals presumably healthy.

A study of the clinical histories of the cases giving a positive reaction elicits the following facts:

Although the clinical histories in cases 1 and 2 were those of cholelithiasis, the diagnosis could not be confirmed in the absence of operation or autopsy. In cases 3 and 4 a stone was found in the common duct, in one at operation—the pancreas is not mentioned; in the second a calculus was found in the common duct, ½ cm. from the ampulla; at autopsy also a chronic pancreatitis, a suppurative cholangitis and hepatitis.

Two of the five cases of diabetes came to autopsy. In one of them there was a widespread hyaline degeneration of the islands of Langerhans and an increase of interstitial tissue. In the second there was fibrosis of the islands of Langerhans and a chronic interstitial pancreatitis. In the case of carcinoma of the pancreas a chronic pancreatitis was also found at autopsy. In the two cases of acute hemorrhagic pancreatitis the diagnosis was confirmed at operation; one of these recovered.

In case 13 the clinical diagnosis was nepholithiasis; at operation no stone was present in the kidney (left) or in the portion of the ureter explored. In the clinical history the pain is described as being present in the back and just below the left costal arch, not radiating. There was no blood in the urine macroscopically or microscopically. The case did not come under my personal observation, but the supposition of the existence of a pancreatic lithiasis, with an associated chronic pancreatitis, should be entertained.

Digitized by Google

CAMMIDGE'S "C-PANCREATIC REACTION"

TOTAL NUMBER OF CASES, FIFTY-ONE

Cases	Diagnosis	No.	Positive	Negative
1– 2	Cholelithiasis	2	2	..
3– 4	Cholelithiasis and cholecystitis	2	2	..
5– 9	Diabetes	5	5	..
10	Carcinoma of pancreas with chronic pancreatitis	1	1	..
11–12	Acute pancreatitis	2	2	..
13	Nepro-lithiasis not confirmed at autopsy	1	1	..
–		13	13	..

Total Cases, 13.
Positive Reactions, 13.

Cases	Diagnosis	No.	Positive	Negative
1– 5	Cholelithiasis	5	..	5
6–13	Cholecystitis	8	..	8
14	Suppurative peripancreatitis, cholelithiasis, cholecystitis	1	..	1
15	Tumor of head of pancreas, of doubtful character	1	..	1
16–17	Diabetes	2	..	2
18	Cholangitis	1	..	1
19–21	Hepatic cirrhosis	3	..	3
22	Perforating duodenal ulcer	1	..	1
23	Gastric ulcer	1	..	1
24	Neurasthenia	1	..	1
25	Intestinal obstruction	1	..	1
26–27	Exophthalmic goitre	2	..	2
28	Vesical calculus	1	..	1
29	Pyonephrosis	1	..	1
30	Chronic endocarditis	1	..	1
31	Chronic portal thrombosis	1	..	1
32–34	Undiagnosed	3	..	3
35–38	Normal	4	..	4
		38	..	38

Total Cases, 38.
Negative Reactions, 38.

Digitized by Google

In the thirteen cases giving positive reactions, an inflammatory lesion of the pancreas was *demonstrated* at autopsy in four; in two, at operation (cases 11 and 12). In two of the thirteen cases gallstones were found in the common duct, one being associated with chronic pancreatitis; the condition of the pancreas at operation in the second case is not stated.

The details of the study of the 38 cases giving negative reactions are as follows:

In cases 1 and 2 the diagnosis of cholelithiasis could not be confirmed in the absence of operation or autopsy. In cases 3, 4 and 5 a cholelithiasis was found at operation; in one of these a single calculus was present in the common duct and one in the hepatic duct; the condition of the pancreas is not stated. In the second case a single large calculus was found in the gall bladder; the ducts and pancreas are stated to have been normal. In the third, a suppurative cholecystitis was associated with the cholelithiasis. The gall bladder contained much thick pus and many stones; the condition of the ducts and pancreas is not stated. There were eight cases in which a clinical diagnosis of cholecystitis was made. Five occurred in the course of typhoid fever and recovered without operation. In the sixth case of cholecystitis the gall-bladder was palpable; recovery without operation. In case 12 there were no stones in the gall-bladder or ducts at operation; the head of the pancreas is stated to have been indurated. In case 13 the gall-bladder and all ducts were free from stones; the statement in regard to the pancreas is that it was "rather hard." A case of great interest (No. 14), and the only one among those giving a negative reaction in which a lesion of the pancreas was demonstrated at autopsy, was an acute suppurative peripancreatitis associated with cholecystitis and cholelithiasis. Extensive interstitial changes also were found in the pancreas at autopsy. Dr. Opie regards

Digitized by Google

the case as primarily one of acute hæmorrhagic pancreatitis. There was a single case (No. 15) of tumor of the head of the pancreas, of doubtful nature in the absence of autopsy. In case 18 the pancreas was found to be normal at autopsy. The diagnoses in the remaining cases are given in the table.

In the thirty-four cases giving negative reactions, two came to autopsy, and an inflammatory lesion of the pancreas was demonstrated in one of these; in the second the pancreas was found to be normal. In the remaining four of the thirty-eight cases the urine tested was from individuals presumably healthy.

Cammidge's[2] latest report on the "pancreatic reaction" is to the effect that in 800 specimens of urine examined by his method there was found evidence of disease of the pancreas in all cases where a positive reaction was obtained, and it was possible subsequently to examine the condition of the gland. A positive reaction was never observed either with a normal urine or in any case in which it was not probable that there was some pancreatic "mischief."

Cammidge's findings in eighty-three specimens of urine from forty-eight cases of diabetes are of interest. In thirty-six cases (75 per cent.) there was a positive reaction, suggestive, as he believes, of their pancreatic origin. In twelve cases the reaction was negative. Four of them came to autopsy. In one the pancreas was found to be normal both macroscopically and microscopically; in two the pancreas was stated to be normal, and in the fourth case the gland was not examined.

The cases of diabetes studied in the Presbyterian Hospital series are too few to be of value. The percentage (71) of positive reactions closely corresponds with that observed by Cammidge. Cecil,[7] in his recent exhaustive study of ninety cases of diabetes mellitus, found anatomical lesions of the pancreas in 88 per cent.

Digitized by Google

Watson,[3] in a late paper on "The Clinical Value of the Pancreatic Reaction in the Urine, Based on Over 250 Analyses," gives a variety of diseases in which he obtained a positive reaction, but in his conclusion states that "if certain facts," which he relates, "are kept in view, and this urinary reaction is carefully studied along with other clinical features of a case," he is convinced that Cammidge's test will prove of great value in the diagnosis of pancreatic disease.

Schroeder's[4] conclusions, based upon a study of 85 cases in which 110 chemical analyses were made, are as follows:

"1. It has been proved that inflammatory and destructive diseases of the pancreas may give rise to the appearance of certain, as yet undefined, bodies in the urine, belonging possibly to the sugars or related compounds.

"2. The reaction is not pathognomonic for disease of the pancreas, in the clinical sense. Extensive clinical observations on the urine in pancreatic and other diseases must finally determine the value of the pancreatic reaction."

Goodman,[5] in a paper of February, 1909, gives the results of the study of sixty-two cases of various abdominal diseases and disorders, including four cases of *experimental* pancreatitis, one of acute pancreatitis, two of chronic pancreatitis, one of carcinoma of the pancreas, one of carcinoma of the stomach and pancreas, four of cholecystitis, two of cholelithiasis, fourteen of diabetes, and ten of cirrhosis of the liver. His conclusions are that the test is of much value and "marks a decided advance in the diagnosis of pancreatic disease."

Eloesses,[6] in an exhaustive study of diseases of the pancreas, largely from Czerny's Clinic, reports the findings in the urine in sixteen cases where Cammidge's test was employed. The diagnoses were confirmed at operation or autopsy. Positive

Digitized by Google

reactions were obtained in four cases of chronic pancreatitis, in two of carcinoma of the pancreas, in one of cancer of the gall-bladder with metastases in the pancreas, in one case of cholelithiasis (stone in the common duct) associated with a pancreatitis, in one of cholelithiasis (stone in the gall-bladder), in one of cholelithiasis, the site of the calculus not stated; in one of carcinoma of the stomach with metastases in the liver; in one case of sarcoma of the retroperitoneal glands the reaction was positive to the earlier Cammidge tests, known as "A" and "B" tests, but which have now been discarded by Cammidge. Negative results were obtained in one case of hepatic cirrhosis and in one case in which the clinical diagnosis was pancreatitis. At autopsy, however, a carcinoma of the intestine was found; the pancreas was normal. Negative reactions were also observed in two cases of dilated stomach.

Turning from clinical to experimental evidence of the value of the "pancreatic reaction," the literature contains the studies of the urine in experimental pancreatitis, by Eichler,[8] Sailer, Speese and Goodman. Eichler's conclusions, based upon positive reactions, obtained from the urine in three cases of acute pancreatitis artificially produced in dogs, are open to the objection of a possibly faulty technique. Sailer and Speese,[9] Speese and Goodman,[10] employing Cammidge's improved C. test, obtained results which, while not conclusive, are highly suggestive of the value of the "pancreatic reaction."

In conclusion, a review of the studies, to the present date, of the urine both in clinical and experimental pancreatic disease, indicates that, while the "pancreatic reaction" is not pathognomonic of, it is strongly suggestive of inflammatory and destructive lesions of the pancreas, and is of much assistance in diagnosis in association with other clinical evidence of disease of this organ.

Digitized by Google

It gives me pleasure to express my indebtedness to Dr. Meakins and his assistants in the laboratory, and to Dr. Lamb, for their co-operation in the study and assistance in the preparation of the tables.

REFERENCES.

[1] Mayo Robson and Cammidge: "The Pancreas, Its Surgery and Pathology," 1907, pp. 243-257.

[2] Cammidge: Surgery, Gynecology and Obstetrics, Vol. VI, 1908, pp. 22-29.

[3] Watson: British Medical Jour., Vol. I, 1908, p. 858.

[4] Schroeder: Jour. American Medical Assn., September 5, 1908, p. 837.

[5] Goodman: Annals of Surgery, February, 1909, p. 183.

[6] Eloesses: Mitteilungen a. d. Grenzgebieten der Med. u. Chir., 1908, Vol. XVIII, pp. 195-294.

[7] Cecil: Journal of Experimental Med., New York, March, 1909, p. 266.

[8] Eichler: Berl. Klin. Woch., 1907, No. 25.

[9] Sailer and Speese: Trans. Assn. Amer. Physicians, Vol. XXIII, p. 540.

[10] Speese and Goodman: Amer. Jour. Med. Sciences, January, 1909, p. 107.

Digitized by Google

XIII.

ON HYPERTROPHY AND REGENERATION OF THE ISLANDS OF LANGERHANS.*

By Russell L. Cecil, M.D., Assistant Visiting Physician.

At the present time there are two crucial problems in connection with the islands of Langerhans which must be solved before the "island theory" can be firmly established. The first, a morphological one, concerns the origin of the islands and the relationship existing between them and the glandular acini; the second, a physiological one, has to do with the connection between the islands and carbohydrate metabolism. It is of certain phases of the former problem that I propose to treat in this paper.

Development of the Islands of Langerhans in the Fetal Pancreas.

Before taking up the subject of hypertrophy and regeneration of the islands, it will not be amiss to review briefly the mode of development of the islands in the fetal pancreas. In this field of research on the islands, the results have been fairly harmonious. Laguesse,[1] studying the histogenesis of the islands in sheep embryos, has shown that the islands are of epithelial origin, and develop in common with the acini from the primary tubules. Pearce,[2] Küster[3] and Weichselbaum and Kyrle[4] have all studied the development of islands in the human embryo,

* (*Reprinted from the Journal of Experimental Medicine, Vol. XIV, No. 5, 1911.*)

Digitized by Google

and have reached almost identical conclusions. The results of their investigations are well summarized in the closing paragraphs of Küster's paper:

1. The islands of Langerhans appear in early embryonic life as anatomically differentiated structures in the pancreas.
2. The earliest anlage is found in offshoots from the ducts.
3. The anlage is marked by three characteristics:
   (a) The nuclei are centrally located.
   (b) The cells arrange themselves in bands or rows.
   (c) The cells are in close contact with capillaries.

The Islands of Langerhans in Congenital Syphilis of the Pancreas.

In congenital syphilis of the pancreas, the normal development of the gland is retarded so that the various structures bear more or less resemblance to those observed in fetal life. Opie,[5] Pearce, and more recently Karakascheff[6] have studied the islands in syphilitic pancreatitis and have noted that the islands, instead of being independent of other structures, are in many instances connected with the ducts or acini by slender cords or tubules of cells.

I have had the opportunity of studying sections from three cases of congenital syphilis of the pancreas.

Case I. (Dr. Opie's case.) Infant, 40 cm. in length; lived three hours. *Anatomical diagnosis.*—Congenital syphilis, interstitial pneumonia, splenic tumor, chronic perisplenitis. *Pancreas.*—Microscopically, the interstitial tissue is greatly increased. The lobules are small and widely separated. The islands are imbedded in the stroma, but have not been invaded by the fibrous tissue. Some of them are in direct connection with the ducts by means of slender tubules lined with flattened epithelial cells (figure 1).

Case II. (Dr. Opie's case.) Infant, 50 cm. in length; lived four hours. *Anatomical diagnosis.*—Congenital syphilis, pemphigus neonatorum, interstitial pneumonia, interstitial hepatitis and pancreatitis, splenic tumor. *Pancreas.*—Microscopically, the interstitial tissue is greatly increased. The lobules con-

Digitized by Google

tain fewer acini than normally. The islands are numerous and surrounded by dense bands of fibrous tissue. Some of the islands are in continuity with ducts, as in Case I.

CASE III. (Presbyterian Hospital, autopsy No. 8,050.) Infant, male, 18 months old. *Anatomical diagnosis.*—Congenital syphilis, interstitial hepatitis, nephritis, pancreatitis, acute broncho-pneumonia. *Pancreas.*—Microscopically, there is a well marked increase of the interstitial tissue. The lobules are uneven in size, but the acini appear normal. The islands are numerous and well preserved. A few of them are found to be connected with ducts by short, slender tubules lined with flattened epithelial cells.

In the protocols of these cases, it will be observed that two of them were new-born, while the third was an infant eighteen months old. In all three cases, there is a well marked interstitial pancreatitis, with more or less replacement of the parenchyma by fibrous tissue. The islands of Langerhans, however, are well preserved and quite numerous. Some of the islands are independent of the surrounding tissue, while others are in direct continuity with the ducts or acini. Occasionally one encounters a small duct from which islands and acini can be seen budding side by side. The connecting link between the island and the duct is a slender cord or tubule composed of a single or double row of low cuboidal epithelial cells (figure 1).

A careful study of the sections from these cases will convince one that Pearce and Opie are correct in considering the changes described as the result of interference with normal growth. The islands of Langerhans, instead of separating from the ducts, as they do under normal conditions, often remain in continuity with the tubular structures from which they have originated. The histological picture is that of a fetal pancreas, the seat of chronic interstitial inflammation.

HYPERTROPHY AND REGENERATION OF THE ISLANDS OF LANGERHANS.

In a previous paper, I[7] have emphasized the fact that hypertrophy of the islands may occur in one or the other of two

Digitized by Google

forms. In the first, or simple hypertrophy, the island may show no abnormality except an increase in size, the arrangement of the cells in irregular cords being still preserved. In the second or columnar type of hypertrophy, the islands assume certain abnormal characteristics, the most striking of which is a change in the shape of the cells from a polyhedral to a high cylindrical form, with centrally placed nuclei.

Regeneration or new formation of the islands from the ducts was first described by Weichselbaum[8] in 1908. In 19 out of 151 cases of diabetes he noted small buds composed of high cylindrical cells, which were growing out from the ducts, and which in serial sections he could demonstrate as connecting links between the ducts and rudimentary islands. These rudimentary islands were also composed of high columnar cells. As the newly formed islands grew larger, they became separated in some instances from the ducts; but a duct could usually be found in the neighborhood of such islands. Weichselbaum thought this mode of regeneration of islands corresponded to that of their embryonic development as described by Pearce, Küster and Karakascheff.

In the same year that Weichselbaum reported these observations, his pupil, Kyrle,[9] described similar regenerative processes in partially depancreatized dogs and guinea pigs. In the neighborhood of the scars, he found many mitotic figures in the cells lining the pancreatic ducts and small buds which differentiated into new acini or new islands. He observed many giant islands but considered the regenerative processes more important from a compensatory standpoint than the hypertrophy of already existing islands.

The researches of Weichselbaum and Kyrle have explained, therefore, in a very satisfactory way the occurrence of two types of island hypertrophy. Simple hypertrophy is merely an

Digitized by Google

enlargement of a pre-existing island. Columnar hypertrophy, on the other hand, is seen in connection with islands newly formed from the ducts.

During a previous study of the islands of Langerhans in diabetes, I[1] became interested in the subject of hypertrophy of the islands; and having since encountered the condition in a number of cases where there was no evidence of diabetes, it seemed worth while to review all the material at hand and, if possible, to contribute more knowledge to the subject. Such a study now appears the more desirable since Herzheimer,[10] in his recent investigations on the islands after ligation of the pancreatic duct, has been unable to find any islands budding from ducts as described by Weichselbaum and Kyrle.

The cases in which I have encountered columnar hypertrophy and regeneration of the islands of Langerhans may be divided into the following groups: (1) diabetes mellitus; (2) chronic pancreatitis; (3) carcinoma of the pancreas; (4) cases in which the pancreas is for the most part normal.

In some cases, the hypertrophy has been more marked than the regenerative changes; in others, the reverse has been true. The hypertrophy is of two types: (1) Simple hypertrophy, in which there is more or less increase of size in pre-existing islands. Such islands preserve their normal round or oval contour and their characteristic architecture. I have never seen islands of this type exceed a diameter of 0.6 of a millimeter. (2) The so-called columnar hypertrophy. This type is much more common. Here the structure of the island is changed, the cells being of a high cylindrical form and arranged in rows like columnar epithelium. In shape, the cells bear considerable resemblance to those lining the larger ducts. The cytoplasm takes the same bright stain with eosin and appears homogeneous. The nuclei, however, unlike those in the cells of the ducts

Digitized by Google

are centrally located. They are large and vesicular and contain several chromatin granules. The cells are arranged side by side in curving and anastomosing bands or rows, sometimes singly, sometimes several rows together. The intimate relation of cells to capillaries is analogous to that seen in the normal island. The cords of cells twist themselves into various shapes, sometimes forming loops that simulate acini; but the absence of zymogen granules and the presence in many instances of a capillary in the lumen of such structures show their real nature. One of the striking traits of these columnar islands is their irregular contour, which is produced by the outgrowth of loops and processes of columnar cells into the surrounding tissue.

Hypertrophied islands of the columnar type may reach dimensions many times greater than those of normal islands: I[7] have recently reported one such island that measured 4 by 3.5 millimeters, and a number of others as large or larger have been reported. Diameters of 0.5 to 1.0 millimeter are not unusual in these cases.

Columnar islands are usually found in the neighborhood of ducts. In serial sections, a direct connection with the duct can often be demonstrated, in which case the island may be either sessile, or connected with the duct epithelium by a slender cord of cylindrical cells (figures 2 and 3).

Regeneration or new formation of islands I have usually found associated with columnar hypertrophy, for the obvious reason that they represent different stages of one and the same process. A small bud or knob of cylindrical cells grows out from the duct, and, as the cells multiply, assumes the form of a small island of the columnar-cell type. The process corresponds closely to that described in connection with the development of the islands in the fetal pancreas. The newly formed islands exhibit a capacity for growth much greater than that

Digitized by Google

of pre-existing islands. One may, therefore, encounter all sizes of columnar islands from that of a bud consisting of only a few cells to that of one of the giant islands already referred to. Moreover, these large islands may send out an offshoot of cylindrical cells several hundred micromillimeters in length, at the end of which another columnar island will develop. Working as I have with autopsy material, I have naturally seen very few mitotic figures in either the ducts or the newly forming islands; but that they occur in large numbers in freshly fixed tissue, as described by Weichselbaum and Kyrle, I do not doubt. The islands develop from the small or moderate sized ducts. I have seen large islands connected with very small ducts and small islands connected with fairly large ones.

The relation which these hypertrophied and newly formed islands bear to the acini is an important phase of the subject. Is it possible for new islands to develop from acini? Can new acini develop from columnar islands? Kyrle, in his experiments on animals, found that new acini as well as new islands could develop from the ducts, but he was never convinced that either one of them might develop from the other. There are undoubtedly columnar islands that are connected neither with the ducts nor with other islands; and there are columnar islands whose columns of cells are apparently continued into glandular acini. It is very hard to decide, however, whether this connection of islands with acini is real or apparent. My own observations have led me to favor the latter view. Newly forming islands, pushing their way in between acini, come into such intimate contact with acinar cells that in microscopical sections one might readily be deceived by the picture. If there is an anatomical connection between the two, I should be inclined to favor the view that new islands were being differentiated from acini, such a process being more in harmony with

Digitized by Google

the fetal development of the islands than a development of acini from islands.

Hypertrophy and Regeneration of the Islands of Langerhans in Diabetes.

Since Opie's study of the islands of Langerhans in diabetes, considerable attention has been given to the degenerative and fibrous changes in the islands so frequently encountered in this disease. Comparatively little, however, has been written about hypertrophy and regeneration of the islands in diabetes. Since lesions of the islands are generally found in association with diabetes, it would be in connection with diabetes that one would expect to find regenerative hypertrophy of the islands most frequently; and such indeed is the case. Herzheimer[11] was one of the first to observe hypertrophy of the islands. He describes some very large islands which he encountered in two cases of diabetes. Hypertrophied islands in association with diabetes have also been observed by Reitmann,[12] Ssobolew,[13] MacCallum,[14] Karakascheff,[6] and me.[7]

The investigators all noted the peculiar columnar arrangement of the island cells in such cases, but offered no explanation of it. Weichselbaum, in the study already referred to, found that the columnar islands were always in the neighborhood of ducts and in some instances directly connected with them.

I have studied the pancreas in one hundred cases of diabetes, with special reference to hypertrophy and regeneration of the islands. In thirty-four out of the hundred cases, I have found one or the other condition present; usually both. By referring to the table, it will be seen that the lesions occurred at all ages and that, although they were generally found in association with chronic interacinar pancreatitis, there were eight

Digitized by Google

cases where there was no interstitial new growth and eleven others in which the fibrosis was inconsiderable.

Other lesions of the islands were associated with hypertrophy and regeneration in thirty-one out of the thirty-four cases. The lesions found were hyaline degeneration in eight cases, round cell infiltration in two, and sclerosis in twenty-eight cases. The three cases in which no other changes were found occurred in young people; and in all three instances the islands were noted as small and scanty.

CASES OF DIABETES SHOWING HYPERTROPHY AND REGENERATION OF THE ISLANDS.

Case number	Age in yrs.	Pancreas.	Islands of Langerhans.
Case 1. Presbyterian Hospital.	57	Well marked chronic interstitial pancreatitis.	Sclerosis and hyaline degeneration. Considerable hypertrophy, sometimes columnar.
Case 2. Presbyterian Hospital.	27	Normal.	Small and very scanty. A few small columnar-celled islands.
Case 3. Presbyterian Hospital.	35	Moderate grade of chronic interstitial pancreatitis.	Quite scanty. Moderate sclerosis. A few small columnar-celled islands.
Case 4 Presbyterian Hospital.	60	Well marked chronic interstitial pancreatitis.	Considerable sclerosis. Many hypertrophied islands of the columnar type.
Case 5. Presbyterian Hospital.	52	Considerable chronic interstitial pancreatitis.	Scanty and show considerable sclerosis. A few small columnar-celled islands.
Case 6. Presbyterian Hospital.	75	Considerable chronic interstitial pancreatitis and fatty infiltration.	Sclerosis and hyaline degeneration. Many hypertrophied islands of columnar type. Some apparently connected with ducts.
Case 7. Dr. James's case.	36	Advanced chronic interstitial pancreatitis.	Considerable sclerosis and hypertrophy of islands, a few of them of the columnar-cell type.

Digitized by Google

Case number	Age in yrs.	Pancreas.	Islands of Langerhans.
Case 8. Royal Victoria Hospital.	20	Simple atrophy of pancreas. Microscopically no increase of interstitial tissue.	Infiltration of leucocytes about some islands. Considerable hypertrophy. A few small columnar islands.
Case 9. Royal Victoria Hospital.	31	Moderate grade of chronic interstitial pancreatitis.	Marked hypertrophy of columnar type and extensive new formation of islands from ducts and acini. Island capillaries sclerotic.
Case 10. Royal Victoria Hospital.	75	Well marked chronic interstitial pancreatitis.	Considerable sclerosis and hypertrophy. One giant island of columnar type, 1,800 micromillimeters in diameter.
Case 11. Royal Victoria Hospital.	29	Considerable interstitial new growth, and infiltration of fat.	Considerable sclerosis and hypertrophy. A few columnar-celled islands, one of them in direct connection with a duct.
Case 12. Royal Victoria Hospital.	70	Well marked chronic interstitial pancreatitis.	Marked hypertrophy and regeneration of islands from ducts and acini, almost entirely of the columnar type. Slight sclerosis.
Case 13. Royal Victoria Hospital.	38	Slight increase of interstitial tissue in places.	Moderate sclerosis. Infiltration of lymphoid cells about some islands. Marked hypertrophy (columnar) and regeneration from ducts.
Case 14. Montreal General Hospital.	28	No interstitial new growth, but infiltration of leukocytes about vessels.	Slight sclerosis, considerable hypertrophy. A few small columnar-celled islands.
Case 15. Montreal General Hospital.	66	Slight amount of chronic interstitial pancreatitis and considerable infiltration of leukocytes.	Well marked sclerosis and hypertrophy. Many hyaline islands. A few columnar islands about ducts.
Case 16. Montreal General Hospital.	26	Considerable infiltration of leukocytes.	Infiltration with leukocytes and sonsiderably hypertrophied. A few islands of the columnar type.

Digitized by Google

Case number	Age in yrs.	Pancreas.	Islands of Langerhans.
Case 17. Mass. General Hospital.	45	Advanced sclerosis of pancreas.	Islands small, scarce, sclerotic. A few of them are columnar in type.
Case 18. Mass. General Hospital.	58	Moderate interstitial pancreatitis.	Sclerosis and hyaline degeneration. A few large columnar islands near ducts.
Case 19. Mass. General Hospital.	53	Mild grade of chronic interstitial pancreatitis.	Capillary walls thickened. Considerable number of large islands of the columnar type near ducts.
Case 20. Mass. General Hospital.	70	No changes except arteriosclerosis.	Moderate sclerosis. A few small columnar-celled islands
Case 21. Mass. General Hospital.	20	Normal.	Small and scarce. A moderate number of small columnar-celled islands.
Case 22. Mass. General Hospital.	60	Advanced interstitial pancreatitis.	Considerable sclerosis. Number of islands small. A few small columnar islands.
Case 23. Mass. General Hospital.	59	Well marked chronic interstitial pancreatitis.	Small and scarce. Moderately sclerotic. Many large columnar islands, some connected with ducts.
Case 24. Mass. General Hospital.	31	Well marked chronic interstitial pancreatitis.	Scarce. Well marked sclerosis. A few small columnar islands.
Case 25. Boston City Hospital.	27	Normal.	Small and scarce but free from sclerosis. A few small columnar islands, apparently connected with acini.
Case 26. Boston City Hospital.	59	Moderate grade of chronic interstitial pancreatitis.	Sclerosis and hypertrophy. Some show hyaline changes. A few columnar islands, one connected with a duct.
Case 27. Pennsylvania Hospital.	51	Well marked chronic interstitial pancreatitis.	Scarce; moderately sclerotic. Some of the islands of the columnar type. One of them connected with a duct; one with acinus (?).
Case 28. New York City Hospital.	50	Marked fatty infiltration.	Numerous; sclerotic, hyaline, hypertrophied. A few large columnar islands.

Digitized by Google

Case number	Age in yrs.	Pancreas.	Islands of Langerhans.
Case 29. Bellevue Hospital.	33	Normal.	Sclerotic, some hyaline, marked hypertrophy of the columnar type.
Case 30. Bellevue Hospital.	73	Moderate grade or chronic interstitial pancreatitis.	Considerable sclerosis and hyaline degeneration. A good many hypertrophied islands of the columnar type, one connected with duct.
Case 31. Mt. Sinai Hospital.	73	Moderate grade of chronic interstitial pancreatitis.	Scarce; sclerotic and hyaline. Many hypertrophied columnar islands about ducts.
Case 32. Presbyterian Hospital.	52	Mild chronic interstitial pancreatitis.	Marked hyaline degeneration of nearly all islands. A few large columnar islands about ducts, one in direct connection.
Case 33. Presbyterian Hospital.	57	Mild chronic interstitial pancreatitis.	Large number of columnar islands, some very large; some connected with ducts (others with acini?). Moderate sclerosis.
Case 34. Bellevue Hospital.	60	Well marked chronic interstitial pancreatitis.	Sclerotic and hyaline. Remarkable hypertrophy of islands in head of pancreas. All of columnar type and connected with ducts or acini.

In twelve of the thirty-four cases, columnar islands were present, but no hypertrophied forms were encountered. Larger forms would doubtless have been found in some of the cases if more sections had been accessible. On the other hand, I have seen several specimens in which a simple hypertrophy of the islands existed, but where the columnar islands were lacking; that is, the pre-existing islands had increased in size, but there had been no new formation of island tissue.

There was no apparent relation between the severity of the lesions in the islands and the extent of hypertrophy and regen-

Digitized by Google

eration of islands. For example, in case 32, practically every pre-existing island in the section had been converted into hyaline material and only a few newly formed columnar islands had appeared. On the other hand, in case 9, there was only a slight sclerosis of the normal islands, and a remarkable hypertrophy and regeneration of the columnar type of island was observed.

Hypertrophy and Regeneration of the Islands of Langerhans in Chronic Pancreatitis.

Weichselbaum[4] has observed regeneration of the islands of Langerhans in some cases of chronic interstitial pancreatitis, where there was no diabetes. I have examined sections from thirty-three cases of chronic pancreatitis of the interlobular type. In ten cases the changes were moderate; in eighteen they were well marked; and in five cases there was advanced sclerosis with extensive destruction of parenchyma.

The cases were associated with the following conditions:

Cirrhosis of liver	13 cases
Gall stones	9 cases
Cardiac and renal disease	6 cases
Chronic cholecystitis	1 case
Ulcer of stomach	1 case
Jaundice	1 case
Fatty liver	1 case
Septic peritonitis	1 case

In these thirty-three cases, the islands were in many instances bunched together and surrounded by dense fibrous tissue, but in other respects they appeared normal. In only three cases was there any evidence of a regeneration of the islands. Two of these cases were among the group associated with cirrhosis of the liver; the other case was that of septic peritonitis. Each of the cases exemplified a different grade of cirrhosis.

Digitized by Google

A few small groups of columnar cells, arranged in the characteristic manner, occurred here and there in the sections, but the hypertrophied forms were absent. The process was so inconsiderable that I have omitted protocols of the cases.

The significant fact brought out by the study of this group is that extensive destruction of the pancreas may occur without there being any compensatory hypertrophy or regeneration of the islands. The islands are spared and no strain is placed upon the function of carbohydrate metabolism. The contrast between this group and the diabetic group is striking. In the latter, some of the most marked examples of regeneration and hypertrophy occurred in pancreases that showed little or no change.

Hypertrophy and Regeneration of the Islands of Langerhans in Carcinoma of the Pancreas.

In carcinoma of the pancreas, the new growth replaces in great part the secreting parenchyma, but the islands of Langerhans show a tendency to persist in the midst of cancerous tissue, just as they survive in advanced cirrhosis of the pancreas. That the islands, too, in some instances are finally destroyed is shown by the fact that in a certain number of cases of pancreatic carcinoma, sugar is present in the urine, while in other cases an alimentary glycosuria is observed.

Pearce,[15] in a study of carcinoma of the pancreas, noted a hypertrophy of the islands along the advancing edge of the tumor. Weichselbaum[8] has observed hypertrophy and regeneration of the islands in some cases of pancreatic carcinoma.

I have studied microscopical sections from seventeen cases of cancer of the pancreas, three of them primary, fourteen metastatic, in none of which is there any record of glycosuria. I have studied these cases with special reference to the islands

Digitized by Google

of Langerhans. In six of them there was only a moderate invasion of the gland by the new growth; in the other remaining eleven cases there was extensive cancerous involvement, with considerable replacement of the parenchyma by the neoplasm. In those cases where the tumor had occluded the pancreatic duct, there was more or less interstitial pancreatitis. The islands, as a rule, appeared normal. In the advanced cases, they were often found bunched together in a fibrous stroma, as in cirrhosis of the pancreas, but still preserving their normal appearance. In several cases the islands had undergone more or less simple hypertrophy, some of them measuring 400 or 500 micromillimeters in diameter. In only one out of the seventeen cases was I able to find the characteristic columnar hypertrophy and regenerative changes which have been already described.

The patient, a woman, aged 64 years, was operated upon for gall stones. At operation, a small, very hard gall-bladder containing stones was removed. Microscopical sections through the thickened wall showed an adenocarcinoma. The patient died a few days later.

Anatomical Diagnosis.—Cholecystectomy; metastatic carcinoma of liver, pancreas, and retroperitoneal lymph glands; malignant stenosis of the pancreatic duct; chronic interstitial pancreatitis; fat necroses; general arterial sclerosis; jaundice.

The pancreas is enlarged and very hard. On section, the lobules are found separated by translucent tissue. There are several fat necroses in the tail of the pancreas. The pancreatic duct is greatly dilated. There are stenoses at several points.

Microscopical sections through the head of the pancreas show a marked increase of the interstitial tissue separating the lobules. The latter are compressed and atrophied. In a number of places there occur masses of large epithelial cells, in some places closely packed together, in others displaying a somewhat tubular arrangement. The islands of Langerhans are numerous and considerably larger than normally and many of them

Digitized by Google

show typical columnar-cell hypertrophy. The columnar islands are usually in the neighborhood of ducts.

Hypertrophy and Regeneration of the Islands of Langerhans in Cases Where the Pancreas Was for the Most Part Normal.

In diabetes, chronic pancreatitis, and carcinoma of the pancreas, the occurrence of hypertrophy and regeneration of the islands may be explained more or less satisfactorily. There remains, however, still another class of cases, a particularly interesting group, where, with none of these diseases present, the islands show definite hypertrophic and regenerative changes.

In the course of routine examinations of the pancreas from autopsies at the Presbyterian Hospital, I have encountered four such cases, and one other has been added through the kindness of Dr. Humphreys of the German Hospital, New York. The following are brief protocols of the cases.

Case I. M. M., female, aged 53 years, well nourished, moderately alcoholic. No evidence of lues. Admitted with typical symptoms of chronic nephritis. Died in uremic coma.

Presbyterian Hospital, Autopsy No. 7,923. *Anatomical Diagnosis.*—Chronic interstitial nephritis; infantile right kidney; arterial sclerosis; hypertrophy of heart; fatty liver; calcified nodes in lungs; chronic fibrous pleuritis; myoma of uterus; chronic cervicitis; vaginal ulcers.

The pancreas is firm, and on section it appears normal. Microscopically, there is a moderate amount of adipose tissue between the lobules, but little if any increase of the interstitial tissue. Marked endarteritis. The islands are very numerous and larger than normally. A considerable number of them are composed of columnar cells. The columnar islands are generally found about the small ducts and some are found connected with the ducts. In some of the larger branches of the pancreatic duct, the epithelium is thrown up into papillomatous folds which appear almost to occlude the lumen of the duct. These folds consist of a delicate central stalk of fibrous tissue which is covered with a single layer of very tall columnar epithelial cells, larger than those lining a normal duct. Here and there are groups of dilated acini, whose cells are flattened and hyaline and whose lumina are filled with a pink-staining, structureless material.

Digitized by Google

CASE II. F. M., male aged 25 years. Student. Admitted for mastoiditis. Had undergone an operation for nephrectomy sometime previously (pyonephrosis). Mastoid cells found filled with pus. Patient died in uremic coma after operation.

Presbyterian Hospital, Autopsy No. 7,777. *Anatomical Diagnosis.*—Pyonephrosis and chronic interstitial nephritis of right kidney; absence of left kidney; chronic cystitis; chronic pulmonary tuberculosis; tuberculosis of peribroncial lymph glands; acute broncho-pneumonia; edema of lungs and brain.

The pancreas is pale and firm; ducts and vessels are normal. Microscopically, the pancreas is free from sclerosis. A few dilated acini lined with flattened hyaline cells occur. The islands are numerous and in some cases considerably larger than normally. A moderate number of the islands are of the columnar-celled type and situated near the ducts. The rest of the islands are normal. The walls of the arteries are not thickened. The main duct appears normal. In some of the larger branches, however, the lining epithelium is thrown up into papillomatous folds, similar to those described in Case I. Many of the cells on those folds have taken on the goblet form.

CASE III. J. D., female, aged 34 years. Moderately alcoholic. No evidence of lues. Marked obesity. Operated on for pus tube. Died twelve days after operation, after running a high continuous temperature.

Presbyterian Hospital, Autopsy No. 3,817. *Anatomical Diagnosis.*—Salpingectomy on right side; cloudy swelling of viscera; obesity; operation wound.

The pancreas weighs 180 grams. It is large, pale, and of firm consistence. Microscopically, the pancreas shows no increase of interstitial tissue, but there are small collections of lymphoid cells about some of the vessels and ducts. The main duct is entirely devoid of epithelium, being lined with cellular fibrous tissue. The islands are very numerous and show extreme hypertrophy of the columnar type. The picture resembles that seen in several of the diabetic cases.

CASE IV. J. W., male, aged 63 years. Temperate habits. No evidence of lues. Admitted to the hospital with symptoms of intestinal carcinoma. Markedly emaciated. Mass in right lower quadrant. Died twelve days after admission.

Presbyterian Hospital, Autopsy No. 7,810.[1] *Anatomical Diagnosis.*—Adenocarcinoma of colon; chronic interstitial nephritis; arterial sclerosis; hypertrophy of prostate.

The pancreas is firm and pale. The ducts are normal. Microscopically, the pancreas shows no increase in the stroma. The acini are normal. The islands are quite numerous and in some instances normal. The greater number, however, are composed of columnar cells and are larger than normally. Some of them are in direct connection with smaller ducts, while others are apparently connected with acini. One large island measured 4 mm. in diameter and is hyaline. There is infiltration of polynuclear leukocytes and lymphoid cells into the walls of the larger ducts, which also show hyaline

Digitized by Google

changes. In some of the larger ducts, the epithelium is of the tall columnar type, folds of which project into the lumen.

CASE V. A. B., male, aged 64 years. Admitted to the German Hospital, New York, in a moribund condition and markedly dyspneic. *Clinical diagnosis.*—Asthma, emphysema, and myocarditis.

[1] This case has been reported by me in the Journal of Experimental Medicine, 1911, XIII, 595.

German Hospital, Autopsy No. 367. *Anatomical Diagnosis.*—Acute broncho-pneumonia; acute and chronic bronchitis (asthma); emphysema; renal calculi; hydronephrosis; compensatory hypertrophy of right kidney; chronic interstitial nephritis; cardiac hypertrophy; arterial sclerosis.

The pancreas is fairly firm. On section, the middle portion of the duct is found to be markedly dilated, but there is no obstruction at its duodenal end. In the middle of the pancreas, near the duct are several small foci 5 to 10 mm. in diameter, which contain a greyish white, soft, coherent material. They do not look like cysts, but rather like masses of some tissue which is very soft; otherwise the lobulation of the pancreas is normal. Microscopically, sections though the soft white areas show them to be small tumors enclosed by fibrous capsules and composed of anastomosing epithelial processes which resemble the epithelium of ducts. These papillary processes are lined with high cylindrical cells some of which are goblet cells. Here and there in the tumor are small collections of mucoid material, evidently the secretion of the cells. The tumor has apparently been produced by the marked proliferation of the epithelium lining one of the ducts. The fibrous capsule of the tumor (wall of dust?) is infiltrated with lymphoid cells. Adjacent to one of the tumors there are several greatly dilated ducts. The parenchyma about the ducts shows a well marked interlobular sclerosis. Another section shows normal ducts and normal secreting parenchyma. The islands of Langerhans, however, are very numerous and many of them show considerable hypertrophy of the columnar type. The newly formed islands are usually in the neighborhood of ducts, and a direct continuation between island and duct can be demonstrated at one point. The larger arteries show advanced endarteritis.

We have then five cases of well marked regeneration of the islands of Langerhans in which there was no evidence of diabetes and no destruction of the pancreatic parenchyma by cirrhosis or cancer. There is, of course, no way of excluding an alimentary glycosuria or transient diabetes in any of them. Briefly they were: (1) cardio-renal disease, (2) pyonephrosis, (3) pyosalpinx, (4) carcinoma of colon, (5) cardio-renal disease.

Digitized by Google

Of the five cases, the two that occurred in young people were associated with infections, while of the other three, two were cardio-nephritics and one was a case of carcinoma of the colon. There is nothing in the cause of death in these cases to explain the regenerative changes in the islands. So far as we know, there is no connection between any of these diseases and carbohydrate metabolism. There is no associated lesion in another organ, common to all five cases, that would serve to explain the condition of the islands, nor does the gross appearance of the pancreas in this group throw light on the question. Microscopically, however, a comparison of the pancreas is rather instructive.

1. .....Adenomatous proliferation of lining epithelium of ducts. Some of the acini are dilated and lined with flattened hyaline cells.
2. .....Adenomatous proliferation of lining epithelium. Some acini are dilated and lined with flattened hyaline cells.
3. .....Collections of lymphoid cells about some of the ducts. The main duct is entirely devoid of epithelium, being lined with cellular connective tissue.
4. .....Adenomatous proliferation of lining epithelium of large ducts. Coats of large ducts are hyaline and infiltrated with polynuclear leukocytes and lymphoid cells.
5. .....Marked adenomatous proliferation of epithelium lining large ducts, producing obstruction of the lumen and dilatation of distal portion of duct. Infiltration of lymphoid cells into walls of ducts.

Of the five cases, three showed definite chronic inflammatory changes in the ducts; in four cases there was a well marked adenomatous proliferation of the epithelium lining the large or medium sized ducts. One or both of these conditions was present in each of the five cases. This adenomatous hypertrophy of the duct epithelium is the same as that which has been de-

Digitized by Google

scribed by Winternitz[16] in association with chronic pancreatitis. The epithelium is thrown up into papillary folds, the lumen being often completely filled with them. The cells are no longer cubical but are high cylindrical; they stain deeply with eosin and often assume the goblet form. The nuclei are usually vesicular.

Winternitz offers the suggestion that the new formation of duct epithelium might be an effort on the part of the pancreas to regenerate after chronic inflammatory processes, but he thinks it more probable that the change in the ducts and the fibrous overgrowth may both be due to a third process, often some form of duct obstruction. From a study of my own cases, I am convinced that the duct changes may be independent of chronic pancreatitis. In only one of the three cases which I have reported was there any interstitial new growth, and in that the sclerosis was confined to the neighborhood of the dilated ducts and apparently secondary to the duct changes.

It is, of course, impossible to establish a causal relationship between either inflammatory or adenomatous changes in the ducts and the regeneration of islands which we have seen associated with them. Since the islands regenerate from the ducts, it would be natural to suspect some connection between adenomatous hypertrophy of the duct epithelium and regeneration or adenomatous hypertrophy of the islands. This suspicion is enhanced by the similarity which exists between the two processes. I agree with Winternitz, however, that both changes should probably be attributed to a third common factor. In all the cases of this group, the regenerative changes are much more marked than the hypertrophic changes. Indeed, the columnar islands are often quite small and duct connections are readily found. In the absence of any evidence of carbohydrate derangement, it is hard to look upon this process as a compen-

Digitized by Google

satory one. It would rather seem to be a reaction following a disturbance of some kind in the ducts. Obstruction of the ducts, as suggested by Winternitz, may be the etiological factor in some cases. In one of my cases (case 5), there was marked dilatation of the larger ducts. In the one case of carcinoma of the pancreas where columnar hypertrophy and regeneration of the islands were observed, there was obstruction and dilatation of the main duct. In this instance, however, the proliferation of the duct epithelium was not noted.

These studies have shown that regeneration of the islands of Langerhans may occur in various conditions, and that such regeneration takes place by means of a budding off of columnar cells from the ducts. I am not sure that there is ever a real connection between these newly forming islands and the adjacent acini, though in some cases, like case 4 in the last group, the association is so intimate that the possibility of a direct connection cannot be excluded. The fact that processes of columnar cells push out between the acini and that in many places they are in immediate contact with acini would explain the apparent continuations of the one into the other that are sometimes seen. The absence of regeneration of the islands in cases of advanced cirrhosis and carcinoma of the pancreas where the islands have been spared, and the occurrence, on the other hand, of regeneration and hypertrophy of the islands in many cases of diabetes where there has been little or no destruction of parenchyma, speak strongly for the functional independence of the islands and for their relation to carbohydrate metabolism.

The occurrence of hypertrophy and regeneration of the islands in cases where there is no evidence of diabetes may be explained in several ways. When associated with cirrhosis or carcinoma of the pancreas, we may look upon it as an effort

Digitized by Google

on the part of nature to replace destroyed islands. In the five cases where regeneration of the islands has been associated with neither diabetes nor destruction of pancreatic tissue, an adequate explanation of their occurrence has not been offered. They have been associated, however, in every instance with abnormalities in the ducts; in three cases with chronic inflammatory changes; in four cases with adenomatous proliferation of the duct epithelium.

Conclusions.

1. Hypertrophy of the islands of Langerhans occurs in two forms: (1) the simple type which is nothing more than an increase in size of pre-existing islands; and (2) the columnar type, in which the islands are composed of anastomosing columns of cylindrical cells.

2. Regeneration of the islands of Langerhans takes place by means of a budding off of columnar cells from the ducts. The process is analogous to the development of the islands in the fetal pancreas.

3. Newly formed islands of Langerhans are composed of cylindrical cells similar in all respects to those constituting hypertrophied islands of the columnar type. The two structures are identical, the latter being a later phase of the former.

4. Newly formed islands of Langerhans are capable of a greater hypertrophy than pre-existing islands. Both types of insular hypertrophy are usually of a compensatory character, the columnar, or regenerative type, being the more important.

5. Hypertrophy and regeneration of the islands of Langerhans occur most frequently in diabetes mellitus (34 per cent. of 100 cases studied). These changes are usually associated with sclerosis or hyaline degeneration of other islands.

Digitized by Google

FIG. 1.

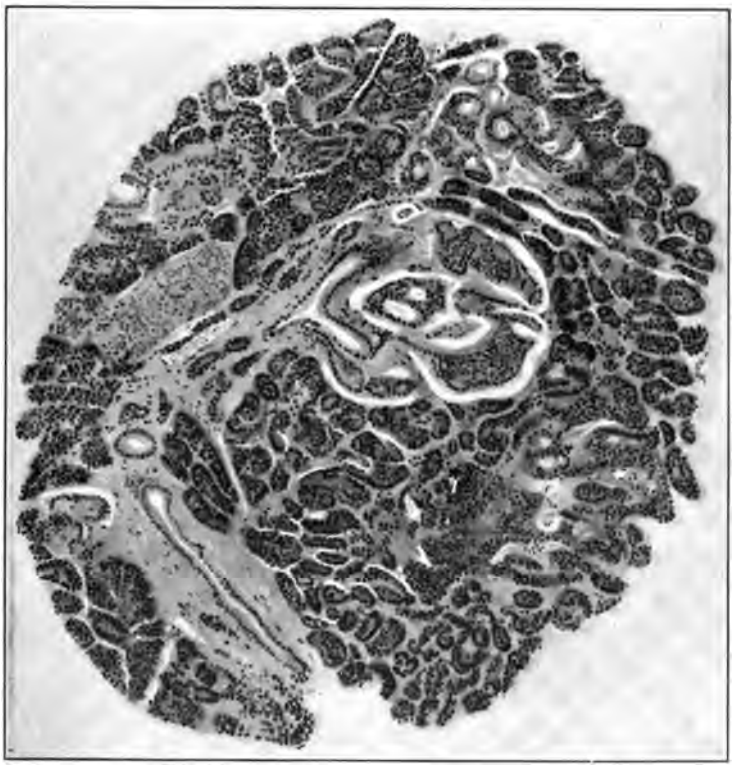


FIG. 2.

Digitized by Google

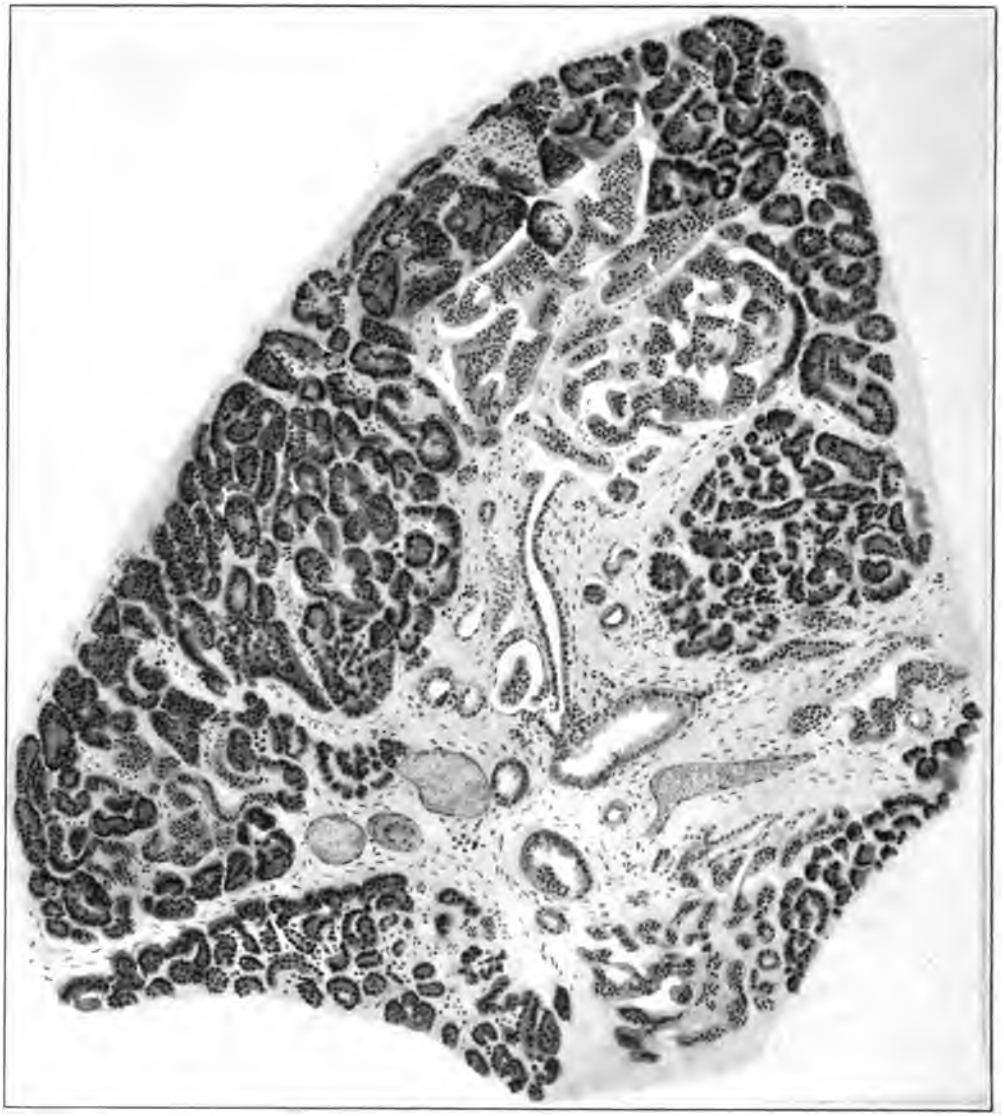


FIG. 3.

Digitized by Google

6. Hypertrophy and regeneration of the islands of Langerhans are occasionally observed in cirrhosis and carcinoma of the pancreas. In some of the most advanced cases, however, the islands have been spared and neither hypertrophy nor regeneration are present.

7. Regeneration of the islands of Langerhans has been noted in five cases in which there was no evidence of diabetes and where the pancreas was for the most part normal. In four of these cases, columnar hypertrophy of the islands was also observed. All five cases were associated with abnormalities of the larger ducts—obstruction, chronic inflammation, and adenomatous proliferation of the lining epithelium.

8. The occurrence of hypertrophy and regeneration of the islands of Langerhans affords considerable evidence in favor of their anatomic and functional independence.

BIBLIOGRAPHY.

[1] Laguesse: Verhandl. d. anat. Gesellsch., 1897, XI, 43.
[2] Pearce: Am. Jour. Anat., 1902-3, II, 445.
[3] Küster: Arch. f. mikr. Anat., 1904, LXIV, 158.
[4] Weichselbaum and Kyrle: Arch. f. mikr. Anat., 1909, LXXIV, 223.
[5] Opie: Jour. Exper. Med., 1900-1, V, 397, 527.
[6] Karakascheff: Deutsch. Arch. f. klin. Med., 1905, LXXXII, 60; 1906, LXXXVII, 291.
[7] Cecil: Jour. Exper. Med., 1909, XI, 266; 1911, XIII, 595.
[8] Weichselbaum: Sitzungsb. d. k. Akad. Wissensch., Math.-nat. Kl., 1908, CXVII, 211.
[9] Kyrle: Arch. f. mikr. Anat., 1908, LXXII, 141.
[10] Herxheimer: Verhandl. d. Deutsch. path. Gesellsch., 1909, XIII, 276.
[11] Herxheimer: Verhandl. d. Deutsch. path. Gesellsch., 1905, IX, 263.
[12] Reitmann: Ztschr. f. Heilk., 1905, XXVI, 1.
[13] Ssobolew: Virchows Arch. f. path. Anat., 1904, CLXXVII, Suppl., 123.
[14] MacCallum: Bull. Johns Hopkins Hosp., 1909, XX, 265.
[15] Pearce: Am. Jour. Med. Sc., 1904, CXXVIII, 478.
[16] Winternitz: Bull. Johns Hopkins Hosp., 1908, XIX, 237.

Digitized by Google

EXPLANATION OF PLATES.

Fig. 1. Congenital syphilis. Case I. The drawing shows an island of Langerhans surrounded by connective tissue, and directly continuous with a small duct.

Fig. 2. Diabetes. Case XXXIII. In the center, a medium sized columnar island is seen in connection with a small duct.

Fig. 3. Diabetes. Case XII. An hypertrophied island of the columnar type is directly connected with a small duct.

Digitized by Google

XIV.

CONCERNING ADENOMATA ORIGINATING FROM THE ISLANDS OF LANGERHANS.*

By Russell L. Cecil, M.D., Assistant Visiting Physician.

Although primary neoplasms of the pancreas are fairly uncommon, medical literature discloses no lack of variety in the types of pancreatic tumor which have been reported. Primary carcinoma of the pancreas is not rare; and a few cases of sarcoma are recorded. Benign tumors of the pancreas, although exceedingly rare, have also been described. Cesaris-Demel[1] has reported an adenoma which he thinks originated from the pancreatic acini. Biondi[2] encountered a fibro-adenoma in the pancreas, the arrangement and morphology of its cells closely resembling those of the pancreatic ducts. Multilocular cystomata of the pancreas have been reported by Garrigues,[3] Heaton,[4] and others. A "myxomatous angioma" of the pancreas is recorded by Baudach.[5]

All of these neoplasms mentioned above are supposed to have originated from either the secretory structures or the stroma of the pancreas. I have been able to find in the literature only three references to tumors of the islands of Langerhans.

In 1902, Fabozzi[6] reported five cases of carcinoma of the pancreas, all of which he believed had arisen from the islands of Langerhans. Reitmann[7] and Helmholtz[8] have both criticized Fabozzi's work and have questioned his conclusions. Judging from the descriptions of his cases, the diagnosis of carcinoma

*(*Reprinted from the Journal of Experimental Medicine, Vol. XIII, No. 6, 1911.*)

Digitized by Google

of the pancreas was in every instance correct. His drawings, however, by no means convince me that the tumors had originated from the islands of Langerhans. The protocols of one or two of the cases lead me to suspect that the pancreatic tumor was a metastatic nodule following carcinoma of the gall bladder. At all events, Fabozzi's theory that they developed from islands of Langerhans can not be accepted until more evidence is forthcoming.

As far as I am aware, only two benign tumors purporting to have originated from the islands of Langerhans have been described. The first of these two cases was that reported by Nicholls[8] in 1902. The tumor, which was not larger than a marrow-fat pea, was situated on the anterior surface of the tail of the pancreas. It had a tawny yellow color, was well circumscribed, rather soft, and exuded a little blood. Microscopically, the tumor appeared as an oval area in the pancreatic substance, measuring 3 by 2.5 mm. It was enclosed by a delicate fibrous capsule. The tumor was composed of elongated and irregular masses of cells bounded by anastomosing bands of fibrous tissue. In a few cases a tendency to form lumina was observed, but a small mass of connective tissue could almost invariably be made out in the center. Minute blood-vessels were found throughout the delicate stroma. The tumor cells were polyhedral and short columnar in form. Their cytoplasm was granular and eosinophilic. The nuclei were vesicular, each containing several dots of chromatin. The cells were slightly smaller than those of the pancreatic acini. Nicholls considered this tumor to be a simple adenoma originating from an island of Langerhans.

Helmholtz's case was that of a negro, sixty-five years old, who died of chronic cardiovascular disease. At the autopsy the pancreas was normal except for a small nodule 5 by 3 by 5 mm. which was discovered accidentally in the substance of the gland. The tumor was dull gray, finely granulated, and sharply circumscribed by a thin capsule. Microscopically, the nodule was found to be composed of masses of polyhedral cells, supported in a delicate mesh-work of fibrous tissue. In some places these cell masses were solid; in others, lumina were seen, about which cells of a columnar type were arranged. The slender trabeculæ that supported the groups of cells contained capillaries. The tumor cells resembled in every way those composing an island of Langerhans. They were arranged in anastomosing cords in intimate relationship with the capillaries, possessed an acidophilic cytoplasm and vesicular nuclei with large chromatin bodies. After studying this tumor. Helmholtz was convinced that it was an adenoma, having its origin in an island of Langerhans.

Description of Case.

The object of this paper is to record a third tumor of the type reported by Nicholls and by Helmholtz.

It occurred in the pancreas of a man sixty-three years old, who was admitted to the second surgical service of the Pres-

Digitized by Google

byterian Hospital on October 26, 1908. His family and personal history were of no interest. For a year previous to his admission he had not been in good health. He was now suffering from pain in the right lower quadrant of the abdomen, constipation, anorexia, loss of weight, and some edema of the feet and ankles.

Physical Examination.—The heart and lungs were normal; the abdomen soft and symmetrical. To the right of the umbilicus a mass 2 by 3 inches could be felt, somewhat tender and fixed to surrounding parts. The skin over the tumor was freely movable. The patient lost ground rapidly. On November 1 he passed about ten ounces of blood per rectum. The urine contained no albumen or sugar. The patient died on November 7.

At the autopsy, performed twenty-four hours after death, the body was found to be that of an emaciated old man. The abdomen only was examined. The liver and spleen were normal. The kidneys were finely granular and had thin cortices. The prostate was enlarged. In the ascending colon there was found a large tumor which extended up to the hepatic flexure. It was annular in shape. The outer surface was smooth and hard; the inner surface was papillomatous, with large necrotic ulcerated areas, and covered with mucus. The lymph glands in the mesocolon were not enlarged. Microscopical sections from the tumor showed it to be an adeno-carcinoma.

The pancreas was firm and pale. The pancreatic ducts were patent. At one point in the caudal portion, near the surface, but completely surrounded by pancreatic tissue, there was a small spherical tumor, the size of a French pea. On section, the cut surface measured 4 by 3.5 millimeters. The tumor was well circumscribed and enclosed by a delicate capsule within which it was freely movable.

Digitized by Google

The tissue was hardened in Zenker's fluid and imbedded in paraffin. Part of the tumor was cut in serial sections and stained with hematoxylin and eosin and with toluidin blue and eosin. The connective tissue stains of Van Gieson and Mallory were also employed.

Microscopically, the tumor, under low magnification (figure 1), is seen to be sharply demarcated from the surrounding pancreatic tissue by a delicate capsule of fibrous connective tissue. It is composed of irregular elongated masses of cells, which lie in a rather coarse mesh-work of hyaline stroma. No ducts are found in connection with the tumor.

Under high magnification (figure 2), the tumor cells are small and poorly differentiated from one another. They appear, however, to be polyhedral or low cuboidal in shape. As a rule, they show no definite arrangement, being packed loosely together several layers thick. In some places, however, a single layer of cuboidal cells lines a sort of acinus which may or may not contain blood. These cells rest directly on the hyaline stroma which supports them. The cytoplasm of the cells contains coarse eosinophilic granules. Their nuclei are large and vesicular and usually show several chromatin bodies. No mitotic figures are seen.

The stroma has been converted for the most part into a homogeneous hyaline material which stains deeply with eosin. Anastomosing bands of this hyaline substance separate and support the alveoli. In some places the stroma retains a somewhat fibrillar structure and a few spindle-shaped nuclei are made out. Small capillaries can be seen coursing through the hyaline trabeculæ. Many of them have previously been destroyed by the hyaline changes; in numerous instances, however, the endothelial lining is well preserved in spite of the hyaline degeneration about it. The occasional occurrence of

Digitized by Google

diffuse hyaline patches, in which atrophic and partially hyaline alveoli may sometimes be seen, indicates that the parenchyma as well as the stroma has been involved in the degenerative changes. Altogether the appearance of the tumor suggests a greatly hypertrophied island of Langerhans with hyaline changes analogous to those seen in diabetes.

In sections stained with toluidin blue and eosin, the tumor cells are found to be free of zymogen granules. They take a light pinkish stain similar to that of the cells of an island of Langerhans or of the duct epithelium. In sections stained by Van Gieson's and by Mallory's connective tissue stains, the tumor cells stain as epithelial rather than as connective tissue structures. The hyaline stroma stains pink with Van Gieson's and dark blue with Mallory's stain.

The pancreatic tissue about the tumor is somewhat compressed. A thin fibrous capsule separates the glandular acini from the tumor cells, but in some places little or no capsule is present and the two types of cells lie in immediate contact with each other. No definite transitions from the one form into the other can be established, though structures suggestive of such a change occasionally occur. In general, the pancreatic acini appear entirely normal. There has been no increase in the interstitial connective tissue.

In view of the resemblance which the tumor bore to an island of Langerhans, these structures were examined with particular interest. They are quite numerous and in some instances appear perfectly normal. The greater number of them, however, exhibit a well marked hypertrophy of the so-called "columnar" type, the insular cells showing, instead of their usual order, an arrangement like that of simple columnar epithelium. Loops and processes of these epithelium-like cells project out into the surrounding tissue, tending to give the island

Digitized by Google

an irregular contour. Some of the loops resemble acini, but their lumina generally contain capillaries. A few of the smaller islands of this type are seen to be outgrowths from the small ductules, with which they still maintain a connection. The larger islands are usually disconnected from the ducts, but in some places are continuous with adjacent acini.

Discussion.

In comparing these three tumors it will at once be seen that while they show slight variations, they present many points in common. All three occurred in the substance of the pancreas. On gross examination, they were almost identical in size and general appearance. Microscopically, they were all sharply circumscribed and enclosed by fibrous capsules. In structure they were quite similar, being composed of irregular elongated masses of cells, supported in a delicate vascularized fibrous stroma. In all three of them the cells showed in places a columnar form and tended to arrange themselves in acini, in this respect simulating the so-called "adenomatous" or "columnar" hypertrophy of the islands of Langerhans. In all three instances, the cytoplasm of the tumor cells was coarsely granular and eosinophilic and their nuclei vesicular, with several chromatin bodies. On the basis, therefore, of this similarity, we may reasonably conclude that the three tumors had the same origin.

Regarding the origin of the tumors, Nicholls points out that they must of necessity arise from one of three structures: (1) the epithelium of the ducts, (2) the pancreatic acini, or (3) the islands of Langerhans. Adenomata which have been described as originating from the ducts are composed, like other tumors of duct origin, of columnar epithelium and exhibit more or less tendency toward the formation of atypical ducts with

Digitized by Google

true lumina. The tumors under discussion, however, are composed chiefly of polyhedral cells, arranged in solid cords and masses and forming no true lumina. On the other hand, if these tumors had sprung from the pancreatic acini, one would expect to find in them some similarity to acini in their structure and in the arrangement of cells. Such resemblance, however, is lacking. The tumor cells, as has been stated, show only an occasional tendency to form lumina or acini and are, moreover, entirely free from zymogen granules. When the cells are columnar and arranged like acini, the appearance is that of a hypertrophied island rather than of secreting acini. When stained by toluidin blue and eosin, Van Gieson's, or Mallory's stain, the tumor cells correspond in every way with those of an island of Langerhans. The elongated masses of cells, supported in a vascular framework of fibrous tissue are exactly analogous to the cell masses composing an island of Langerhans. Moreover, the cells themselves with their coarsely granular, acidophilic cytoplasm and vesicular nuclei rich in chromatin force one to the opinion that the tumors had their origin in an island of Langerhans. It is also significant that in my case the tumor showed extensive hyaline degeneration. This change, when it does occur in the pancreatic parenchyma, is usually seen in the islands of Langerhans.

It is safe to conclude, therefore, that all three of these tumors developed from islands of Langerhans. The question next to be answered is: Are these tumors true neoplasms, or are they merely giant islands? In other words, have we to do with genuine adenomata or simple regenerative hypertrophy of the islands? The problem which confronts us is not a new one. In the breast, in the liver, in the prostate, and even in mucous membranes, the distinction between adenoma and regener-

Digitized by Google

ative hypertrophy is at times difficult or impossible to make. In the pancreas, regenerative hypertrophy of the islands of Langerhans has been described in cases of diabetes by Reitmann,[7] by MacCallum,[10] and by me.[11] More recently, Weichselbaum[12] and Kyrle[13] have reported hypertrophy of the islands in chronic pancreatitis and in experimental lesions of the pancreas. According to these authors, not only do existing islands hypertrophy, but a new formation of islands takes place from the ducts, the new islands budding off from the duct epithelium very much after the manner of island formation in fetal life.

There was no history of diabetes in any of the three cases under discussion. In none of them was there evidence of chronic pancreatitis. In the case, however, which I have reported, it is significant that the islands show extensive regenerative hypertrophy. Their appearance has already been described. Many of them are considerably larger than normally and their cells tend to arrange themselves in single rows, with large vesicular nuclei centrally located. The cells are poor in granules and definitely columnar. The columns are separated by capillaries. In some of these islands a connection can be demonstrated, on the one hand, with the small ducts, and on the other, with the adjacent acini. The former connection is more apt to be seen in the small newly forming islands; the latter, in the hypertrophied islands. A hypertrophied island of this type suggests in a general way an adenoma; in fact the change was originally described by Reitmann as "adenomatous" hypertrophy.

In my case, at any rate, there is evidence that the islands had been put to a strain, and that in response to this strain they had undergone hypertrophy. The fact that the tumor showed hyaline degeneration rather suggests that diabetes, the

Digitized by Google

commonest cause of both hyaline degeneration and hypertrophy of the islands, had been instrumental in this case. At the time the patient was in the hospital, however, there was no sugar in his urine. It is possible that by the hypertrophy of the islands his tolerance for glucose was increased to such a point that sugar disappeared spontaneously from the urine. I recall one other case in my experience where there was no history of diabetes but where the islands showed slight hyaline changes.

In a previous study of the pancreas in diabetes,[11] I encountered a giant island, not so large as the tumor just reported, but comparable to it.

The case was that of an old man, seventy-five years of age. He had had diabetes for fifteen years, and finally died of pneumonia. At the autopsy, the pancreas was infiltrated with fat. Microscopical sections revealed an unevenly distributed new growth of the interstitial tissue. In places the sclerosis was quite marked. The islands were hypertrophied and were often bunched together in patches of dense fibrous tissue. One very large island was found which measured 1.8 by 1.6 mm. in area. It was readily seen with the naked eye.

Microscopically, the large island is surrounded by a capsule of fibrous tissue which separates it entirely from the surrounding pancreatic tissue. In two or three places, small processes of island tissue project into the capsule, but elsewhere the border is regular. In their arrangement and structure, the cells of the island in part resemble those of a normal island, but in many places, especially in the outgrowths into the capsule, the island has taken on an adenomatous appearance, the cells being of the columnar type and arranged in single rows which tend to form loops or pseudo-acini. It is noticed that the secreting parenchyma is autolyzed while the cells of the island are still well preserved.

In another diabetic pancreas I found an island measuring 0.9 by 0.7 mm. in diameter. This island also exhibited the columnar type of hypertrophy. In several other cases of diabetes, islands which measured 0.4 to 0.5 mm. in diameter were encountered.

Digitized by Google

If we arrange the three tumors and the giant islands in a column with reference to their dimensions, an interesting fact is brought out:

Helmholtz's tumor	5.0 by 5.3 mm.
Cecil's tumor	4.0 by 3.5 mm.
Nicholl's tumor	3.0 by 2.5 mm.
Islands in diabetic pancreas (Case XXVI)	1.8 by 1.6 mm.
Islands in diabetic pancreas (Case XXIX)	0.9 by 0.7 mm.
Diameter of islands found in other cases of diabetes	0.4 to 0.5 mm.
Diameter of average normal island	0.1 to 0.2 mm.

On examining these figures it will be seen that it is almost impossible to draw a line between the tumor class and the giant island class, so gradual is the gradation in size.

The relation of these tumors to the surrounding tissue is also of interest. All three of them had capsules, but in my own case, the capsule was thin, and in a few places entirely absent. At these points the tumor cells lay in immediate contact with the glandular acini. I could find no definite transitions from acinar to tumor cells, though several suspicious forms were seen. The existence of islands of this size, whether they be neoplasms or merely hypertrophied forms, constitutes, I think, another argument in favor of the independent structure and functions of the islands. It is hard to see how exhausted acini could produce such remarkable pictures.

SUMMARY.

Small encapsulated tumors of the size of peas, or even smaller, are occasionally found in the pancreas. These tumors are benign, and have a structure similar in all respects to that of an hypertrophied island of Langerhans. The distinction between adenomata and forms of regenerative hypertrophy, sometimes so difficult to make in the breast, prostate, liver, and other organs, is not easily drawn in the present case. The fact that one may encounter all gradations in the size of islands,

Digitized by Google

Digitized by Google

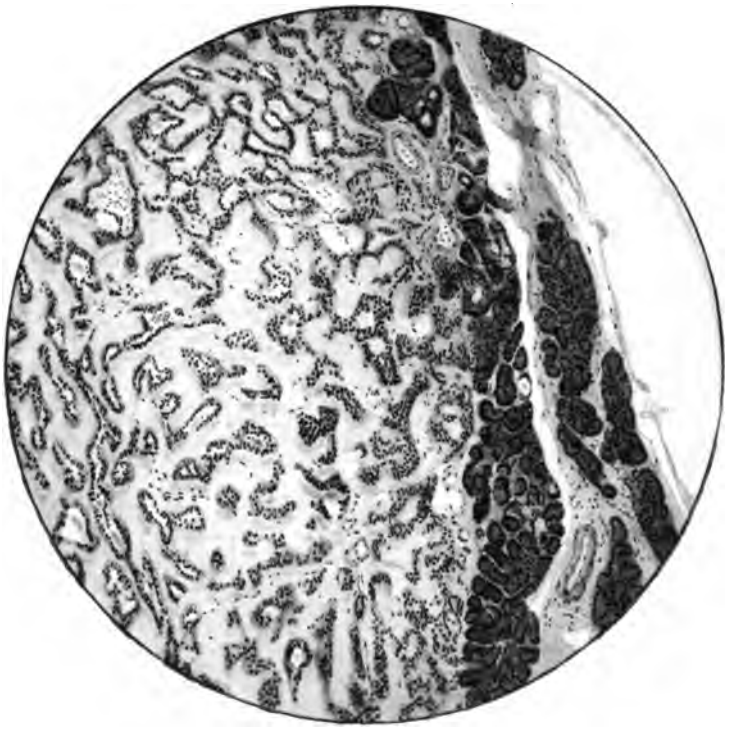


FIG. 1.

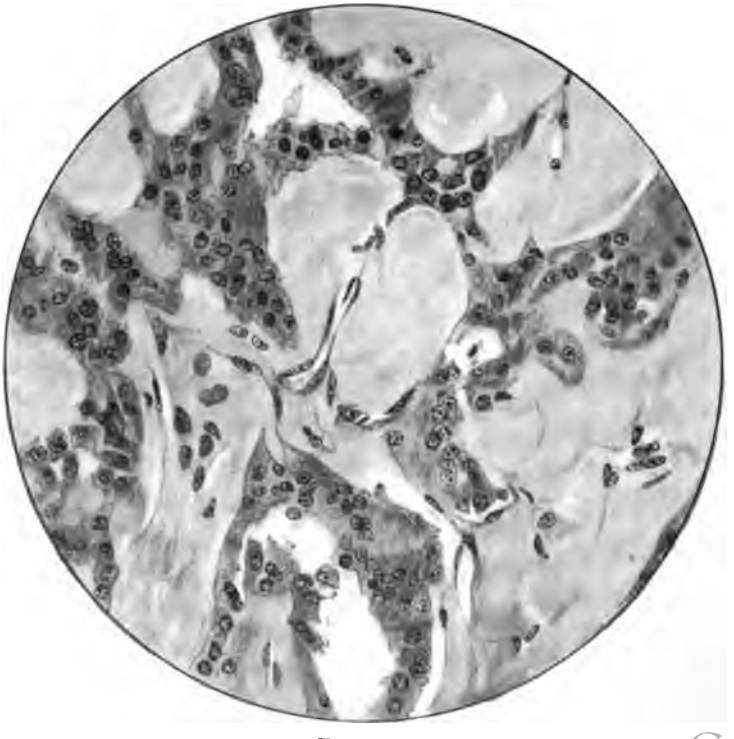


FIG. 2.

Digitized by Google

from that of the normal island to that of the tumors, suggests that it is more reasonable to consider such tumors merely as hypertrophied islands rather than as adenomata originating from islands.

BIBLIOGRAPHY.

[1] Cesaris-Demel: Arch. p. le sc. med., 1895, XIX, 225.
[2] Biondi: Contributo clinico e sperimentale alla chirurgia del pancreas, Clin. Chir., 1896, IV, 131, 145.
[3] Garrigues: Med. Rec., 1882, XXI, 286.
[4] Heaton: Brit. Med. Jour., 1901, II, 1160.
[5] Baudach: Inaugural Dissertation, Freiburg, 1885.
[6] Fabozzi: Beitr. z. path. Anat, u. z. allg. Path., 1903, XXXIV, 199.
[7] Reitmann: Ztschr. f. Heilk., 1905, XXVI, 1.
[8] Helmholtz: Bull. Johns Hopkins Hosp., 1907, XVIII, 185.
[9] Nicholls: Jour. Med. Research, 1902, VIII, 385.
[10] MacCallum: Am. Jour. Med. Sc., 1907, CXXXIII, 432.
[11] Cecil: Jour. Exper. Med., 1909, XI, 266.
[12] Weichselbaum: Sitzungsb. d. k. Akad. d. Wissensch., Math.-nat. Kl, 1908, CXVII, 211.
[13] Kyrle: Arch. f. micr. Anat., 1908, LXXII, 141.

EXPLANATION OF PLATE LXXIX.

FIG. 1. Part of the tumor, showing adjacent pancreatic parenchyma. Low magnification. (Leitz objective No. 3; ocular No. 4.)

FIG. 2. Part of the tumor under high magnification. (Leitz objective No. 7; ocular No. 4.)

Digitized by Google

Digitized by Google

XV.

ABDOMINAL PAIN AS AN INITIAL SYMPTOM IN TYPHOID FEVER WITH SOME STATISTICS ON ITS CAUSATION.*

By Herbert Swift Carter, M.D., Assistant Visiting Physician.

One occasionally hears the statement that Typhoid Fever may have abdominal pain as its initial symptom but the author has never seen any amplified discussion of this interesting and important fact nor any definite statement as to the causation for the pain.

It is with this in view that the following report is made on the subject of abdominal pain, as an initial symptom, especially with reference to its presence in affections of the Gall-bladder, complicating Typhoid.

The chief painful complications which may first call attention to the Typhoid are:

1. Acute Catarrhal Cholecystitis.
2. Typhoid Appendicitis.
3. Intestinal Perforation.
4. Simple colic from gaseous distention (unimportant).

1. *Cholecystitis.*—In examining the histories of the last 1815 cases of Typhoid Fever occurring in the Medical Services of the Presbyterian Hospital between 1897 and 1911, there were twenty-four cases of complicating, acute, catarrhal cholecys-

(*Reprinted from the Journal of the American Medical Association, May 25, 1912.)

Digitized by Google

titis. In two of these the initial symptom of the Typhoid was acute abdominal pain, which, together with two cases occurring in the practice of Dr. E. H. Pershing of Woodmere, L. I., one of which the author saw in consultation, made a total of four cases in which pain was the initial symptom.

Before giving the general statistics of the entire series in which the Gall-bladder was first involved, it seems worth while to give short case histories of the cases in which pain was the initial symptom.

CASE I. P. D. Age 43. Was apparently in usual health when he began rather suddenly to have pain referred to right hypochondrium, where there was also tenderness. This continued throughout entire course of the typhoid which dated from the onset of the pain. Gall-bladder only indefinitely made out on account of rigidity of muscles. Liver enlarged.

CASE II. D. K. Age 11. Perfectly well and went swimming, while in the water was seized with severe abdominal pain in right hypochondrium. He was then ill at home with fever for fifteen days before he was admitted to the hospital. Gall-bladder not felt. Liver not enlarged. Pain lasted twenty-three days, severe at first, later less, always accompanied by tenderness. Ran a typical typhoid course.

CASE III. F. B. Age 21. Had been in usual health, but keeping irregular hours for sleeping and eating. Pushed a roller over the tennis court one morning and on his way to the house directly after, was seized with severe abdominal pain, which was referred to left anterior lumbar region and upper abdomen. Pain and exquisite tenderness soon localized over region of liver and gall-bladder, here it persisted throughout a mild typhoid and a relapse. A short period of anurea followed by urine in which were a few red cells make it probable that the lumbar pain was due to renal colic. The diagnosis of cholecystitis was first suggested in this case by Dr. Forbes Hawkes. The temperature apparently began only at time of seizure. Gall-bladder and liver both enlarged and tender. Leucocytes varied from 8,000 to 12,000 per cubic mm. The initial symptoms were so severe that a diagnosis of perforating duodenal ulcer was considered.

CASE IV. Reported by Dr. E. H. Pershing. C. S. Has been perfectly well when he was suddenly taken with very severe pain in the upper abdomen, was almost in collapse. Seen by the late Dr. A. J. McCosh in consultation, who first diagnosed acute perforating duodenal ulcer. As some of the symptoms were a little confusing it was decided to wait a few hours before operating. The pain soon localized over gall-bladder and patient went through a typical typhoid course.

Digitized by Google

All of these cases made a perfect recovery.

The tabulation of the points of interest about the twenty-six cases of Acute Cholecystitis occurring in the course of Typhoid is as follows:

1. Ages range from 11 to 62 years. Eleven males and thirteen females.

2. No cases gave definite history of previous trouble. One had had a feeling of epigastric fullness after meals with indigestion and vomiting two months before, another case gave the same history sixteen months before. No tenderness in either.

3. Sixteen were classed as mild, eight as severe, two as mild.

4. Pain was the initial symptom in four cases.

5. In the other twenty-two cases the pain with evidence of gall-bladder involvement came on from the 7th to 65th day of the typhoid. Average on the 19th day.

6. The symptoms lasted from two to fifty-four days, most of them for only a few days, *i. e.*, two to four days.

7. In all, the pain was referred to the region of the gall-bladder and in practically all there was local tenderness.

8. In eleven cases the gall-bladder could be definitely palpated, in five it was uncertain and in the remainder it was not palpable.

9. In the eleven positive cases all but two had enlarged and palpable livers as well, apparently a distinct association.

10. There was jaundice in four cases.

11. Fever. Cases in which the cholecystitis came on during the febrile period showed little additional elevation of temperature except in some of the severe cases. Those that developed the complication during convalescence showed a distinct rise in most of the cases, from 1.5 to 3 F.

12. In nine cases in which the leucocytes were counted when the complication developed during the typhoid, seven showed no change in leucocytosis. Two showed a rise to 10,000 and 20,000, although these were classed as clinically mild cases.

13. Four cases were operated upon with the following results:

(*a*) Hydrops with stone in cystic duct (no previous history of trouble).

(*b*) Distended gall-bladder and adhesions to stomach. (No previous history of trouble.)

(*c*) Gall-bladder enlarged, not opened.

(*d*) Gall-bladder enlarged, aspirated, no culture made.

Case (*a*) died. Another case died of hemorrhage and showed inflamed gall-bladder with calculi in it.

Digitized by Google

2. *Appendicitis.*—In this series there were three cases of complicating acute appendicitis, in one case of which the abdominal pain from this cause was the initial symptom. Two other similar cases were reported verbally to the author by Dr. F. P. Solley from St. Luke's Hospital, New York, making a total of five cases.

Of the five cases of acute appendicitis there were no diagnostic points of especial interest. In three of the cases the inflammation of the appendix was the initial symptom, two of them being operated upon, after which they proceeded regularly with their Typhoid. The third was milder.

In the other two, one developed acute symptoms on the thirtieth day, and the other on the forty-first day of their Typhoid, showing that it is an early and late possible complication.

3. *Intestinal Perforation.*—In the 1815 cases of Typhoid Fever referred to there were twenty-six complicated by perforation of the intestines. In no one of these was the perforation the initial symptom of the disease, although one occasionally finds the statement in text-books that such perforation may be the first recognized symptom, particularly in the ambulatory type. This is undoubtedly true but of rare occurrence.

Digitized by Google

XVI.

THE OPERATIVE TREATMENT OF FRACTURES.*

By Joseph A. Blake, M.D., Visiting Surgeon.

One has only to read the articles that have appeared during the past year to appreciate the widespread interest that exists in the treatment of fractures by open operation. Almost without exception, the writers seem to have taken the stand that fracture patients should not suffer from too close adherence to inherited customs or dicta, and that they should benefit with the rest, from the advances of aseptic surgery. The statements as to the indications for operative treatment, as a rule, have been sound and conservative, and few have had the temerity to advise operations for all cases. Briefly stated, the consensus of opinion seems to me to be that a cutting operation is indicated when there exists a strong probability that a good functional result will not be obtained otherwise. This view is the one I myself have arrived at by a sort of evolutionary process.

My first operations were for non-union. Gradually the scope of the indications came to include irreducible fractures in which the chances of non-union were great, or in which if union was attained there would be in all probability loss of function. Naturally the scope grew still further to include fractures which, although reducible, could not, for one reason or another,

*Read before the "Clinical Congress of Surgeons of North America," at Philadelphia, Nov. 13, 1911.

(*Reprinted from Surgery, Gynecology and Obstetrics, April,* 1912.)

Digitized by Google

be retained in position. As experience became greater, conviction became stronger as to the outcome in any given case, and when the result seemed sufficiently dubious, the surer operative method was carried out. As to what constitutes a reasonable doubt as to the ultimate results from non-operative treatment, depends so much upon the thousand and one conditions that may be present in the patient and also upon the ability of the surgeon to meet them, that it is practically impossible to state in so many words what fractures should be treated without and what by operation.

Again, one surgeon may be able to do rapidly, accurately and cleanly what would be practically impossible for another; so there are considerations to be taken into account other than the conditions present in the patient. In fact, there is no province of surgery in which the results depend more upon the mechanical skill and cleanliness of the operator.

This paper is based upon 106 operations of mine of which I have complete records. They do not include operations for fractures entering joints in which the operation was done for ankylosis or removal of fragments. Of the 106 cases, 5 were for fractures of the clavicle, 8 for fractures of the humerus; 5 for fractures of the olecranon, 17 for fractures of the radius and ulna, 21 for fractures of the femur, 43 for fractures of the patella, and 7 for fractures of the tibia and fibula.

The methods of internal fixation were various. In some dependence was placed upon the inequalities of the ends of the fragments; in others, chromic gut, copper, bronze or silver wire, nails, screws, dowels, pins, or plates were used; and, I may say, I still use all of these with the exception of medullary dowels. I have always believed that the less non-absorbable foreign material used the better, and my next preference to nothing is chromicized gut, and I prefer a single screw to a

Digitized by Google

plate and eight screws. Even as the indications for operation vary so do those for the method of internal fixation. The amount of internal fixation depends upon whether it is only necessary to steady the fragments until the external fixation is applied, or whether it is to be subjected to violent strains, as may happen, for instance, in some fractures of the femur. It has been amply proven by experimental and clinical evidence, that a constant strain will loosen the strongest forms of internal fixation. Just as a suture drawn too tight will produce absorption and cut the soft parts, so will a constant strain draw the screws of a plate no matter how well introduced. The point I wish to make is that we have to rely chiefly upon external dressings; the function of the internal fixation being to obviate motions or displacements which may be caused by muscular action, or by sudden strains, such as may happen during the application or change of external splints or dressings. One of the chief advantages of internal fixation is the possibility of early and frequent passive motion of neighboring joints without endangering union.

The occurrence of non-union is not so very rare, even when the fragments have been maintained in end to end position by ordinary external splints. I have seen such results, notably in the femur. I have also seen non-union occur when the femur had been wired. In these cases non-union has usually been attributed to the presence of the wire. When, however, the wire was changed for a plate which kept the fragments rigidly fixed, union resulted in spite of the presence of much more foreign material.

The question as to the effects produced by metallic substances upon the nutrition and growth of bone, seems to me to be still undecided. In my experience, the only metallic substances that have seemed to produce irritation under aseptic

Digitized by Google

conditions have been those consisting partly, or wholly, of copper. In one patient I removed a bronze wire after it had been in the ulna for two years; in another, after it had been in the clavicle for one year. The skin over the first was unchanged, but it lay in a bed of serum and soft granulations; in the second instance a sinus had formed. In another case an encircling copper wire amputated a femur one year after it had been introduced. Two encircling wires had been put about the three oblique fragments. During the year considerable enlargement of the bone had occurred, whether from excessive reparative action, or not, it is difficult to say. Both wires were in channels lined with granulations; and at one of them a spontaneous fracture occurred. (Figs. 1 and 2.) In one of my earlier plating operations I used a brass plate because I was in a hurry and could get no other material from which to make a plate. (In those days I made my own plates.) In this case a slow infection developed, after ten days of what seemed an aseptic course. The plate was removed on the 25th day; soft union was present and later became firm. Whether the late infection was accentuated by the presence of the brass, is a question.

Mild infections apparently do not interfere with union, but, on the other hand, seem to stimulate the formation of callous. Infections severe enough to cause necrosis of tissue manifestly will prevent union.

In my series there were three mild infections; all in operations upon the femur. A rather excessive production of callous was present in all, and union did not seem to be delayed, but even seemed to be accelerated. By this statement I do not wish to appear to make light of infection, for it must be considered the worst misfortune that can happen in operations for fractures.

Digitized by Google

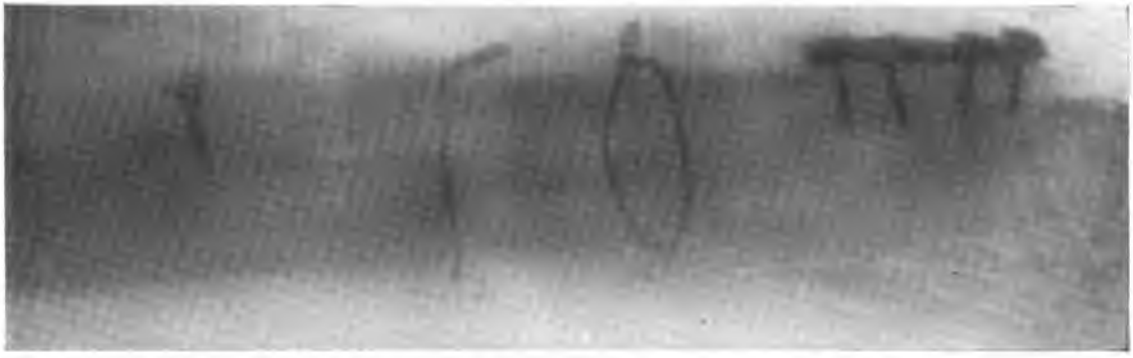


FIG. 1.—Radiograph of Comminuted Oblique Fracture of femur in a woman 68 years of age, three months after operation, in which a screw, two wires and a plate were used.

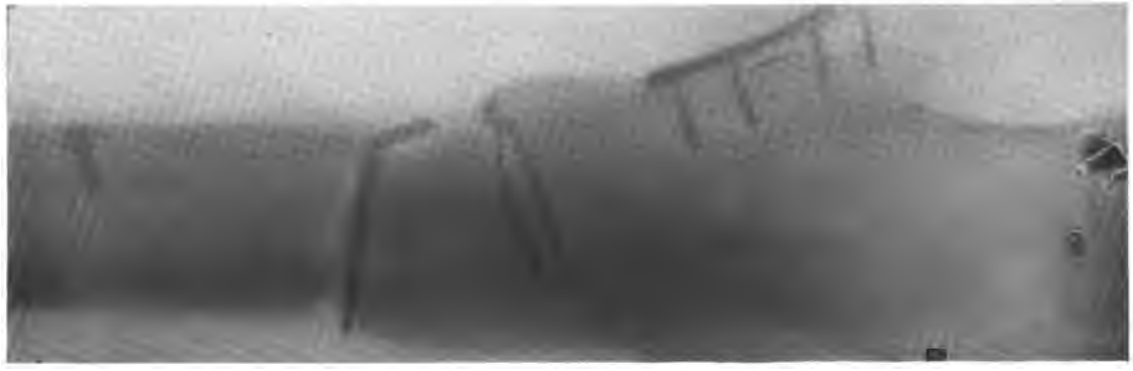


FIG. 2.—Radiograph of same fracture as shown in FIG. 1. One of the wires has produced absorption and spontaneous refracture.

Digitized by Google

FIG. 3.—Radiograph of a humerus six weeks after a wiring operation for an infected compound fracture. Sequestra in place.

FIG. 4.—Sequestra removed six weeks after wiring of an infected compound fracture of the humerus. Same case as in FIG. 3.

Digitized by Google

A beautiful illustration of the result of infection is shown in figures 3 and 4. The patient was admitted to the Presbyterian Hospital five days ago in extreme sepsis, with a history of operation for a fracture an uncertain time before. The arm was a bag of pus which was draining imperfectly from a large sluggishly granulating wound. The white ends of the fragments could be seen in the wound. The radiograph (Fig. 3), showed very distinctly that the dead ends had separated, and with a little force they were pulled off the fragments. It is interesting to note that the line of separation formed at the holes that had been drilled through the fragments for the introduction of a suture.

Infection must be eliminated if good results are to be expected, and if one cannot operate with absolute faith in his technique, he should not operate on fractures.

It seems to me that the greatest improvement toward the avoidance of infection has come with the use of powerful forceps for controlling and reducing the fragments. In my hands they have shortened the time to about one-third of what used to be consumed in an operation. By their use reduction can be accomplished with far less injury to the soft parts; the fingers and hands do not have to be inserted into the wound, and plates and fragments are held absolutely fixed while the screws are introduced, thus causing every screw to have a similar bearing, and consequently all to hold in the same direction at once. It is a principle well known to all mechanics that to get the full holding benefit from screws the substance to be fastened together must be rigidly clamped in position when the screws are being introduced. If this is not done, the strain of one screw may be even exerted against another; and, if an external strain or stress is applied, one will give away after another, just as the threads do when a piece of cloth is ripped.

My first plating operations were done seven years ago. The plates I used were faulty in principle, being wide and concaved longitudinally to fit the convexity of the bone. I only used them for fractures of the femur, and recognizing the

Digitized by Google

strain they would be put to, made them in this shape to give them the requisite strength and also to allow the screws to be toed in; for I could not obtain screws threaded to the heads with a coarse thread. I made several plates of silver, and one of steel besides the brass one I have already alluded to. In order to thread the screws to the head, I had them made on the lathe because I could not get machine screws with coarse enough threads. I was cogitating on how to get wood screws threaded to the head, when I obtained some of Lane's. These, with his narrow reinforced steel plates, solved the problem. It only remains now to get reliable plates made of the best tool steel, properly tempered and annealed. I think they should be annealed to a dark blue, thus making them to be a little softer than an ordinary spring temper.

My variations from Lane's technique have been in the use of the Lambotte clamps, with which I reduce the fracture, and then hold the plate in place while it is screwed on (Fig. 5). I find that with these clamps I no longer have to use traction for reducing fractures; for even in old fractures of the femur with overlapping, the fragments held in the clamps can be angulated out of the wound, and the ends held in position while the limb is again straightened, reduction being accomplished rapidly and easily with a minimum of traumatism. In fractures of smaller bones such as those of the forearm, if the clamps are put on close to the ends of the fragments and then one clamp grasped in each hand, by crowding the knuckles together, a tremendous amount of steady force can be applied and any fracture reduced without a jump or a slip.

I have been using these clamps for the past two years, and all my plating operations during that time have been done with them and Lane's plates. I now would hesitate to operate on a fracture, unless I had them, whether I expected to plate or not.

Digitized by Google

FIG. 5. Lambotte clamps holding Lane plate in place. The screws are introduced before the clamps are removed.

Digitized by Google

Digitized by Google

In these two years I have used 17 Lane plates, and all with the exception of four, two of which were removed because of infection, and two for not holding, are still reposing quietly in their hosts.

A brief summary of my operations in groups is as follows:

Clavicle.—There were five operations for fracture of the clavicle, three for irreducible fracture at or near the middle, the cause of the irreducibility being interposition of muscle; and two for fracture close to the mesal extremity which could not be retained in position. Three were sutured with chromic gut and two with bronze wire. There were no infections and union was obtained in all. In one fracture at the mesal extremity, the bronze wire was close under the skin and a sinus developed later and the wire was removed one year after the operation.

Humerus.—I have records of only eight operations upon the humerus, although I recollect several others. There were a number of operations for old and recent fractures entering the elbow and shoulder joints in which revision of the joint or excision of fragments were the only possible procedures and in which, therefore, no type method was employed and they are, consequently, not reported.

Of the eight operations six were done for irreducibility, and two for non-union. Four were sutured with chromicized gut, including one of the cases of non-union; one with silver wire and one with copper wire. Two were plated with Lane plates. Bony union was obtained in all and there were no infections with the exception of a plating for a compound fracture containing clothing and earth. The infection in this patient was very mild, the plate being left in for six weeks, when it was removed on account of a persisting sinus. The screws were loose. This case is included to show that a plate is of distinct value, although there is probability of infection and subsequent removal. In this case I could not keep the fragments together with a gut suture, which I consider preferable to any metallic substance for compound fractures when there is probability of infection and suppuration.

Olecranon.—There were five operations for fracture of the olecranon, one by Dr. McWilliams. One was of four months' standing, and was complicated by an anterior dislocation of both radius and ulna. The others were recent. Three were done with lateral sutures of chromic gut, and the one by Dr. McWilliams by circular wiring through the fragments. The results in all were perfect.

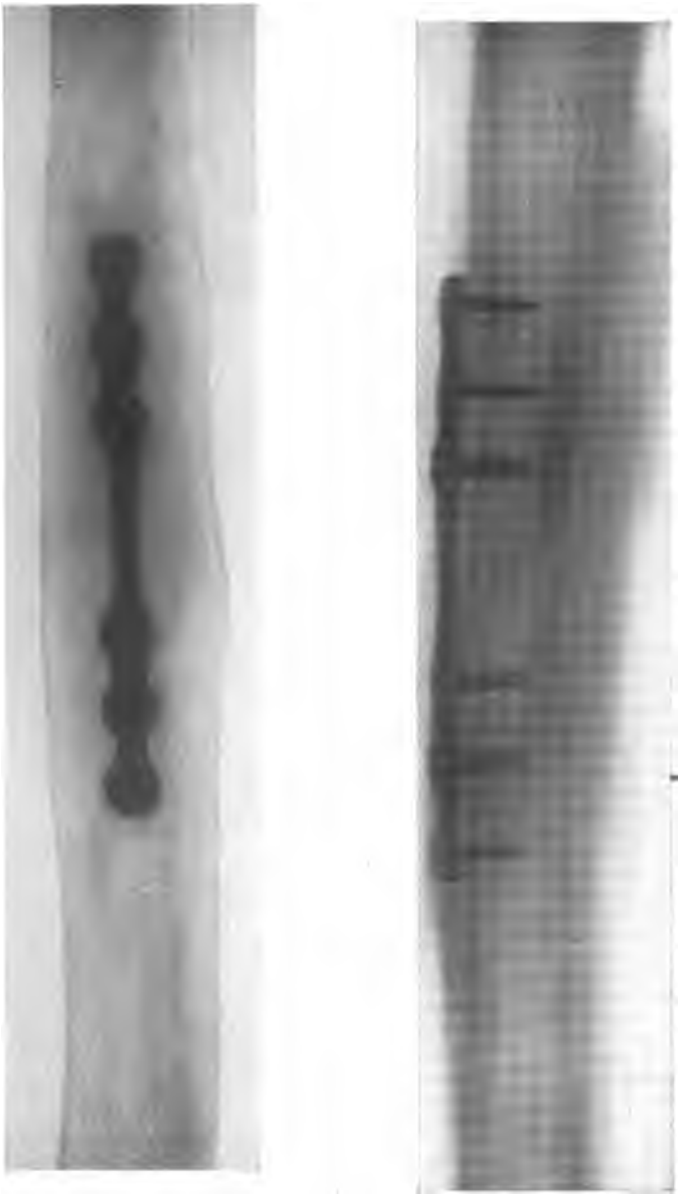
Radius and ulna.—There were seventeen operations for fracture of the radius and ulna, exclusive of those for fracture of the neck of the radius and revisions of malunited fractures of its distal extremity. In fifteen of the

Digitized by Google

seventeen both bones were broken; in the remaining two the radius alone was fractured and repeated ineffectual attempts at reduction over a period of two weeks had been made. Of the fifteen fractures of both bones, eleven were operated upon because of irreducibility and four for non-union. It is safe to say that all were irreducible, for the ununited fractures had not been reduced. In six both bones were operated upon; in nine it was only necessary to cut down upon one bone, the fracture of the other being an incomplete or reducible one. In five cases no internal fixation was found to be necessary, the irregularities of the ends of the fragments being sufficient to retain the position when accurately reduced. In five chromic gut sutures were used; in three phosphor bronze wire, and in one silver wire. In three cases Lane plates were used, in two on both bones, in one on the radius alone. There were no infections and bony union was obtained in all. The functional results in all were excellent. In one plating operation on both bones there is some bowing of the ulna, but three-fourths of pronation and supination is present. In one case a phosphor bronze wire was removed from the ulna two years after operation, it being superficial beneath the skin and causing irritation. It was loose in the bone, being surrounded by granulations.

My feeling in regard to these fractures is that far more should be operated upon than is customary. This is especially so of fractures of the proximal portion of the shaft of the radius, where mesal bowing of the fragments is extremely difficult to prevent by external splints. One ineffectual attempt to reduce under an anesthetic is a sufficient indication for operation. Repeated attempts cause more traumatism than an open operation; and operations on these bones can be carried out safely and with less liability to infection than is the case in most fractures elsewhere. Furthermore, most of them, particularly those occurring in childhood, can be retained in position if they are perfectly reduced, without any internal fixation, on account of the sharp irregularities of the ends; and, when internal fixation is necessary a chromicized gut or kangaroo tendon suture usually suffices. Plates will seldom be found necessary and only in those cases in which there is a marked tendency to angulation, which probably cannot be prevented by external splints.

Digitized by Google



Figs. 6 and 7.—Radiographs of plated transverse fracture of the femur in a girl 7 years of age, nine months after operation.

Digitized by Google

FIG. 8.—Radiograph four years after a wiring operation for a malunited transverse fracture in a boy of 6 years of age. Operation was done seven weeks after the injury because of angulation and shortening.

Digitized by Google

Femur.—There were twenty-one operations for fracture of the femur; twenty for fractures of the shaft on eighteen patients, two being operated upon twice; and one for an ununited fracture of the neck.

The ages of the patients varied from five to sixty-eight years.

There were twelve typical plating operations; nine with Lane's plates, one with a steel plate 4 inches x 1 inch, one with a brass plate and one with a silver plate; in one operation a silver plate was fastened on with circumferential wires, the faulty screws not holding; in one comminuted oblique fracture, a small plate, two wires and a screw were used; in one oblique fracture a nail was used, being withdrawn later by a wire that had been left attached to its head and protruding through the wound; in three operations for oblique fractures single screws were used; in two operations medullary dowels were used, one of bone (sheep's tibia), one of aluminum; and in one patient wire alone was used.

The indications for operation upon the fractures of the shaft were: non-union in 9; vicious union in 6, irreducibility or inability to retain in position in 5. The single operation for fracture of the neck was for non-union in a man aged twenty-five years.

Primary union of the soft parts took place in seventeen of the twenty-one operations. Of the four infections, two were in the earlier plated cases in which the operations were long and much traumatism was inflicted. The plates also were clumsy. One was of steel, the other of brass. This last case has already been alluded to. Both of these infections were mild and union occurred before the plates were removed. The third infection was unexplained. It happened in the case of a boy eight years of age, plated with a Lane plate two days after the injury. The plate was removed seven weeks after operation. Union was delayed but the ultimate result was excellent. In the remaining case of infection the result was not so fortunate. The infection was a severe streptococcus one and resulted in osteomyelitis and eventual disarticulation at the hip. The patient recovered. The results in this case can be charged up to faulty judgment with as much propriety as to faulty technique. The patient, a child five years of age, had been run over by an automobile and had suffered a fracture at the middle of the femur, a rupture of the ligamentum patellae and a separation of about one-half of the skin of the leg. She was treated tentatively. The leg was infected and a greater part of the skin from the knee to the ankle sloughed off. In the meantime, the femur united at a marked angle because of the impossibility of applying proper fixation. The operation; division of the fracture and plating with a Lane plate, was done in the presence of an apparently clean, although extensive granulating wound, reaching from the knee to the ankle; but no doubt virulent streptococci were present and the field of operation was contaminated.

In two patients, both plated with Lane plates, although there was no infection, the plates did not hold. The screws at one end of the plate drew,

Digitized by Google

probably because of improper external fixation, resulting in one case in union with marked angulation, in the other in non-union. Both were replated with perfect result.

The ultimate result as regards union and function was excellent in all cases with the exception of the one that came to amputation and one other, already mentioned, in which an encircling copper wire caused absorption and spontaneous fracture one year after operation. (Figs. 1 and 2).

My present attitude in regard to operations for fracture of the shaft of the femur is that all should be plated that cannot be reduced and retained in reduction. A moderate amount of displacement is permissible in oblique fractures; but, to my mind, in transverse fractures, reduction without over-lapping, is a prerequisite to non-operative treatment. Since union usually takes place in children and since in them accommodation to deformity is more perfect, more displacement is allowable without recourse to operation.

In regard to closure of the wound in the soft parts in these operations, I always approximate the structures accurately but very loosely with as few interrupted sutures of catgut as possible. The skin is united with interrupted sutures of silkworm gut placed about an inch apart, the idea being to permit drainage between the sutures. It is suicidal, or rather, homicidal, to use drains when plates or other non-absorbable materials are used.

Patella.—I have records of forty-three operations for fracture of the patella, and I am positive that there are several more that have been missed in the search of the hospital records. Twenty-six were reported by me in a paper read at the meeting of the American Medical Association in 1904. All of my cases, with the exception of two of my earlier ones, have been operated upon by the method I described in that paper; namely, by suture with chromicized gut of the tears in the aponeurosis lateral to the patella. This method has been found rapid, safe and effectual. No infections, bony union and complete restoration of function have been obtained in all cases.

Tibia and Fibula.—Of the seven operations for fracture of the tibia and fibula, four were for non-union, two for vicious union, and one for a recent fracture of the tibia involving the knee. Four were wired, two were sutured with chromicized catgut. In one no fixation was employed. No plates were used.

Bony union was obtained in all. No infections occurred.

Digitized by Google

XVII.

THE CLINICAL FEATURES AND TREATMENT OF ACUTE GASTRIC AND DUODENAL ULCER.*

By Ellsworth Eliot, Jr., M.D., Visiting Surgeon.
With the Assistance of
J. A. Corscaden, M.D., and J. W. Jameson, M.D.,
Second Assistant Visiting Surgeons.

Although the medical and pathological aspects of an ulcer occurring in the stomach or duodenum had long been recognized, it was commonly regarded as a fatal complication until scarcely thirty years ago, when Mikulicz made the first attempt to cure such a condition by surgical intervention. Although he was unsuccessful, yet the soundness of the principles which he had carried out was quickly recognized, and by following his example other surgeons have achieved considerable success and have brought the operation for the relief of perforation to a very high degree of perfection.

Notwithstanding this progress, perforations still frequently escape recognition or are mistaken for other lesions, and the resulting delay in the application of the proper treatment leads to the needless sacrifice of many lives. It is for this reason that the importance of the early recognition of a perforation by the internist has been frequently emphasized. He ordinarily is the first to see the patient, and it is by him that either the

* Read before the Buffalo Academy of Medicine.

Reprinted from the Annals of Surgery, May, 1912.

Digitized by Google

correct diagnosis must be made or the gravity of the symptoms recognized as indicating a condition which can be satisfactorily dealt with by the surgeon only.

In a paper read by invitation before the New Jersey State Medical Society in 1908, and subsequently published in the journal of that association as well as in the American Journal of Surgery in October, November, December, 1908, and January, 1909,[30] the writer discussed with considerable detail the typical clinical features and treatment of this condition. It will, therefore, be unnecessary to indulge in needless repetition, although the importance of the subject warrants the mention of the more prominent symptoms in order that they may serve as a standard of comparison in speaking of the less frequent but equally important atypical variations of which they are capable.

Briefly, the perforation is usually preceded by a more or less well-defined history of gastric disturbance, which in many instances does not differ materially from that of a chronic dyspepsia; exceptionally the perforation may occur without the slightest premonition at any time of day or night in a patient who, up to that time, has enjoyed perfect health.

The onset of the perforation is marked by severe pain. This is undoubtedly the most constant subjective symptom. It is almost always knife-like in character, epigastric in its location, and is frequently borne by the patient only with the greatest difficulty. If it comes without warning the patient's task or occupation is suddenly interrupted, and if he is aroused from sleep any movement becomes difficult or impossible. The pain is usually increased by inspiration, by turning from one side to the other, by raising the body, unassisted by the elbows, to a sitting posture, and possibly by the flexion of one or both thighs. These different ways of eliciting or intensifying the

Digitized by Google

pain, variable according to the location of the exudate and the direction of the spread of the peritonitis, are material aids in reaching an accurate diagnosis.

Vomiting, although by no means constant, is next to pain the most important subjective symptom. In Petrén's[102] series of 92 cases it was present in 43 cases of gastric and 10 cases of duodenal perforation. It was absent in 22 cases of gastric and 5 cases of duodenal perforation. The initial vomiting due to peritoneal irritation occurs probably in from one-half to two-thirds of all cases of acute perforation shortly after the advent of the pain, and may recur with increasing frequency as the peritonitis becomes further advanced.

The character and the quantity of the vomitus depend upon the character and the quantity of the stomach contents at the time of perforation. It is a well-known fact that perforation may occur in stomachs quite empty, in which event the vomitus consists chiefly of bile and mucus; on the other hand, in stomachs more or less distended with food, the vomitus may be abundant, and consists of partially digested food. Blood in any considerable quantity is at all times a rare constituent.

Vomiting is more commonly observed in cases of duodenal than in those of gastric perforation, for in this latter condition the physiological act of vomiting is, of necessity, materially modified by the fact that even with but slight expulsive effort the gastric contents escape more easily downward through the perforation into the peritoneal cavity than upward through the œsophagus, whereas in perforation of the duodenum the stomach wall is intact and the mechanism of vomiting, in consequence, is undisturbed. In gastric perforation proper, the frequency of vomiting is thought by some to depend upon the facility with which the gastric contents can escape into the peritoneal cavity. Thus, Leroy and Minet and

Digitized by Google

Durrgey,[72] with several other authors, state that in perforation near the cardia and lesser curvature vomiting is less frequent than where the perforation is nearer the pylorus or greater curvature. Based upon this theory is the treatment suggested by Paterson,[97] that in those cases in which through inaccessibility a perforation, usually near the cardia, defies either detection or satisfactory closure, an immediate posterior gastro-enterostomy provides for the rapid escape of the gastric contents into the jejunum, and thereby prevents, through overflow, their passage into the general peritoneal cavity.

Before leaving the question of vomiting, the writer wishes to call attention to the fact that in two cases herewith reported, this symptom was entirely absent. In Case XI the patient had had occasional attacks of vomiting prior to the perforation, while during the thirty-six hours between the perforation and operation, no vomiting whatever occurred. In Case X there was neither vomiting nor even the suggestion of nausea.

Shock, with its associated symptoms, is certainly the exception in both gastric and duodenal perforations. In many cases the pulse is scarcely increased in frequency during the first two or three hours after perforation, and in Case X reported by the writer the pulse was strong, of excellent tension, and but 48 in frequency seven hours after the perforation. If shock is present, it is at least so transitory in most instances that by the time of the first medical examination it has practically disappeared. It is essential to emphasize this fact, for the opposite view, frequently held by different authors, leads to erroneous diagnosis and to dangerous if not fatal delay in operation. For similar reasons it is well, in this connection, to emphasize the fact that shock, when present, is no contra-indication to immediate operation. This statement is again at variance with the more or less widespread belief that under

Digitized by Google

such circumstances operation should be deferred until the shock has subsided. Every hour of delay in diagnosis or of delay in operation after the diagnosis has been made decreases the chances of the patient's recovery.

The objective symptoms are most important. The character of the respiratory movement of different segments of the abdominal wall, the preponderance of thoracic over abdominal breathing, the presence of tenderness and especially of muscular resistance, together with the dulness in either the left or right flank, due to the exudate, have all been fully described in the paper already referred to. The writer is still of the opinion that muscular resistance is the most constant and most valuable objective symptom, and in its point of maximum intensity the most reliable guide to the site of the lesion. Attention is again directed to the value of an increase in the resistance of the costal arch as an aid to diagnosis. In their escape the gastric or duodenal contents must of necessity pass downward through either the right or left lumbar gutter. The former in duodenal perforation is facilitated by the absence of the transverse colon which, in gastric perforation, inhibits for a time the passage of fluid into the left flank. In either event the resulting peritoneal irritation is reflected by an increase in the resistance of the lower segment of the corresponding costal arch which, in expiration, is less easily and less extensively displaced toward the vertebral column than on the non-affected side.

The disappearance of liver dulness is, still, in the writer's opinion, an exceptional and therefore unreliable symptom. In duodenal as well as in many cases of pyloric perforation, little if any gas passes into the peritoneal cavity. The same is true of gastric perforations at a distance from the pylorus in which perforation occurs when the stomach is empty. It is chiefly

Digitized by Google

in perforations occurring shortly after eating, at a time of gastric fermentation, and in a zone of the stomach more or less remote from the pylorus that gas may be expected to escape in sufficient quantity to modify the normal liver dulness. Petrén[102] observed gas on opening the peritoneal cavity in about one-third of his cases of gastric perforation and in only two of 18 duodenal perforations. In a note he states that observations in regard to the disappearance of liver dulness were not made with sufficient frequency to be of any value. In a number of these cases, however, the gas was in such small quantities that it could have had no appreciable effect on the normal area of liver dulness.

Dulness in either flank is unquestionably a symptom of great value. Small amounts of fluid in this location can, in the writer's experience, be readily detected with the aid of auscultation. In the hands of others, auscultation does not always seem to render the same assistance in eliciting this symptom. It is well in this connection to call attention to the symptom described by Shoemaker,[105] in which a dull percussion note over fluid in the flank gradually assumes a tympanitic quality when by an increase in pressure of the percussed finger against the abdominal wall, the fluid is displaced and the intestine brought into closer proximity.

The frequency with which cases of acute perforation fail to be recognized and the consequent unnecessary prolongation of an operation in which the utmost speed is essential by the making of one or more exploratory incisions at a point distant from the lesion certainly justify a brief consideration at least of their differential diagnosis.

Although conditions with which acute perforation might be confused should theoretically be limited to lesions in the right upper quadrant or at least to lesions in the epigastric

Digitized by Google

region, yet as a matter of fact it is more frequently confused with an acute appendicitis than with any other condition. Both are frequently preceded by a history of gastric symptoms of variable intensity and degree; in both the onset of the attack is usually marked by severe pain with or without vomiting, the elevation of both pulse and temperature, and a definite leucocytosis. They are generally to be distinguished by the fact that in gastroduodenal perforation the onset of the pain is sudden, while its location is more definitely epigastric. In appendix the pain, at first referred to the region of the navel, is ordinarily reflected within a few hours to the right lower quadrant. This rule, however, has many exceptions. In the early hours after the onset of either lesion the diagnosis should be easily made by the difference in the physical signs; while in perforation the tenderness and rigidity are most marked above the level of the navel to the right (duodenal or pyloric) or to the left of the median line (cardia), according to its location, in acute appendicitis the tenderness and rigidity are most marked in the right lower quadrant. In perforation the dulness is elicited in either the right or left loin, while in appendicitis it is more tardy in its appearance and is located at first between the anterior superior spine and the umbilicus.

After the first 12 to 24 hours the physical signs more closely resemble each other if the perforation is in the vicinity or below the level of the pylorus, for by this time, or even earlier, the contents of the stomach or duodenum have passed through the perforation down through the right lumbar gutter into the pelvis, and the resulting rigidity and tenderness referred to the lower part of the abdomen may be more intense than the rigidity at first elicited over the site of the perforation. With advancing and general peritonitis, the dif-

Digitized by Google

ferential diagnosis becomes increasingly difficult and sometimes impossible without the aid of an exploratory incision.

In case of error the correct diagnosis is readily made as soon as the abdominal cavity is opened, by noting the actual gross pathological condition. If the appendix is exposed by the McBurney incision, the prolongation of the operation is almost *nil,* for, by this route, the peritoneal cavity can be opened in less than a minute and the opening subsequently used for pelvic drainage. The difference in the gross pathology of perforation and acute appendicitis was fully described by the writer in his previous paper,[20] and the importance of the subject seems to warrant its repetition at this time.

The fact that acute gastric and especially acute duodenal perforation is frequently mistaken for acute appendicitis warrants a brief statement of the chief gross pathological differences of these two conditions when, under the impression that an acute inflammation of the appendix exists, the right lower quadrant of the abdomen is opened. In both, fluid usually escapes when the peritoneum is divided. In gastric or duodenal perforation, this fluid is yellow, usually free from odor, and is distributed uniformly and without change of color, odor, or consistency around the cæcum and between the intestinal loops that lie in the pelvis. It is usually more abundant as the upper part of the ascending colon is exposed. The change in the appendix is limited to its peritoneal coat which, like the serous investment of the adjacent intestine, may be reddened and injected. In a severe acute appendicitis, on the other hand, the fluid near the parietal peritoneum is usually serous. It is relatively small in quantity and free from odor. As the appendix is approached, however, the fluid rapidly becomes turbid, and finally the appendix, discolored and friable, is usually found surrounded by thick offensive pus which

Digitized by Google

may be in whole or in part shut off by adhesions from the general peritoneal cavity. In the absence of such characteristic changes both in and around the appendix, the source of an incipient general peritonitis of dubious origin most probably lies in a perforation of the stomach or duodenum, and the exposure and thorough search of these two structures should follow immediately.

The lesions in the upper right quadrant for which acute perforation may be mistaken include those of the gall-bladder, the pancreas, and the appendix. The rare cases of appendix in this region include those in which the cæcum is undescended, the appendix, in consequence, being out of its normal position, and those equally rare cases in which the tip of an unusually long retrocæcal or paracæcal appendix lies in proximity to the liver or gall-bladder and in this situation becomes gangrenous.

Severe acute cholecystitis, especially of the gangrenous type, with or without perforation, may simulate acute perforation at or near the pylorus so closely as to render differential diagnosis well nigh impossible. Both subjective and objective symptoms differ in degree. Both have in common a sudden onset, severe pain intensified by respiration, vomiting, constitutional disturbance, and prostration. In perforation the pain is usually nearer the mid-line than in acute cholecystitis, although exceptions to this rule are numerous. In both there are tenderness and rigidity over the upper part of the right rectus and the righ costal arch. In cholecystitis, if the gall-bladder lies beneath the costal border, tenderness may be elicited by pressure on the junction of the eighth and ninth costal cartilages; in perforation, tenderness is referred by the patient to a position nearer the mid-line in the epigastrium. In perforation, the rigidity is more intense and involves a

Digitized by Google

wider area than is generally the case in cholecystitis. In several instances of perforation, herewith reported, the dulness extended from the loin to the outer margin of the rectus muscle; in cholecystitis the fluid is much smaller in amount and the dulness is obtained over a correspondingly smaller area.

On opening the abdomen, the correct diagnosis is obvious. Fortunately a right pararectal incision, enlarged if necessary by a second incision extending from its upper extremity inward to the median line, exposes the gall-bladder, the duodenum, and the pyloric end of the stomach, and serves equally well for the detection of an enlarged, swollen, tense, and discolored gall-bladder on the one hand or for a pyloric duodenal perforation on the other. Through this same incision the appropriate treatment of either condition can easily be carried out.

The differential diagnosis between perforating ulcer and acute pancreatitis may be much more difficult than between perforation and either appendicitis or cholecystitis. In the latter conditions, difficulty is experienced only when the perforation is either at the pylorus or its immediate vicinity, for in that event the symptoms are most pronounced on the right side. If, on the other hand, the perforation is in the middle of the stomach or between this point and its cardiac extremity, the symptoms are referred either to the mid-line or to the left of the mid-line, and the resulting exudate together with the contents of the stomach give dulness in the left loin. Both subjectively and objectively, therefore, the symptoms of acute perforation near the cardia can simulate those of an acute appendicitis or cholecystitis only when the appendix or the gall-bladder lie to the left of the median line—an improbable though not impossible location. On the other hand the pan-

Digitized by Google

creas, like the stomach, extends to either side of the median line. It is obvious, therefore, that an acute pancreatitis, involving the head of that organ, will result in objective and subjective symptoms which are referred to the right upper quadrant, while in similar involvement of its tail the symptoms are referred to the left upper quadrant and to the left loin. In the former event the symptoms may be almost identical to those of a duodenal perforation and in the latter case to those of a perforation near the cardia. The two conditions are to be distinguished mainly by the detection of some disturbance of the pancreatic digestive function. At the time of operation, however, a correct diagnosis is usually not difficult. Again, as in cholecystitis, a pararectal incision gives convenient access to the head of the pancreas. On opening the peritoneal cavity abundant free fluid is found, which, in pancreatitis is dark-colored if not actually blood-stained, while in duodenal perforation the fluid is acid in reaction, not infrequently mixed with gas, and contains a certain amount of stomach contents. The occurrence of small patches of fat necrosis in the overlying omentum is extremely suggestive of pancreatitis. Inspection and palpation of the stomach shows that organ normal and probably in a distended condition, while on deeper palpation the head of the pancreas is felt to be swollen, elastic, and enlarged.

Errors in the diagnosis of acute perforation of the stomach are not confined to lesions of the appendix, gall-bladder, or pancreas, but include other conditions as well. The occasional obstipation, together with vomiting, may suggest intestinal obstruction. In Case XI herewith reported, even in the total absence of vomiting for 36 hours subsequent to the perforation, this diagnosis was made by two surgeons in view of the marked obstipation and also in view of the

Digitized by Google

fact that, owing to the spread of the peritonitis, the physical signs in the left lower quadrant were as marked as those in the upper right part of the abdomen. Mention is also made in the published reports of cases by different observers of operation for supposed ectopic gestation and even for renal calculus.

The consideration of the differential diagnosis of perforating ulcer could not be passed over without emphasizing one final important point that, no matter what the condition which may simulate a perforation, immediate operation is just as necessary and delay may be just as dangerous as if a perforation actually existed. In other words, that any lesion of which the subjective and objective symptoms simulate perforation should be immediately referred to the surgeon, and that delay for any reason can only be prejudicial to the patient's interest and is therefore entirely unjustifiable.

A knowledge of the essential gross pathological features of perforating gastric and duodenal ulcer facilitates their rapid discovery when the abdominal cavity is opened. The perforation is most frequently located on the anterior wall at or near the pylorus. From this point perforations are found with diminishing frequency along the lesser curvature toward the cardiac end of the stomach. They are much less commonly found at or near the greater curvature or on the posterior wall of the stomach. (The writer has never found a perforation in this last mentioned situation.)

Ulcers in which perforation may occur are single or multiple; in the latter event ulcers may be found simultaneously in the stomach and duodenum. The coexistence of ulcers is not uncommon. F. Brunner[16] estimates that in from one-quarter to one-third of all cases multiple ulcers are present. On the other hand, multiple perforations are rare. The writer,

Digitized by Google

in his previous paper,[80] collected 18 cases of this character, and to this number must now be added four others reported by Petrén[102] in his series of 92 cases and four more reported by Villard and Danatello[114] in a series of 115 cases. In the same paper the writer also called attention to the fact that in many instances perforations occurred simultaneously at corresponding points on the anterior and posterior walls of the stomach; in other cases the perforations were situated either close together or were separated by a considerable interval on the same side of the stomach. In almost every instance of multiple perforation, the second perforation was not found at the time of operation and was discovered only at the subsequent autopsy. The ease with which multiple perforations are overlooked emphasizes the necessity of a rapid but careful search of both sides of the stomach before the abdominal wall is closed; while the anterior wall may be quickly inspected, the posterior wall can be adequately searched only after opening the lesser peritoneal cavity either through the gastrohepatic omentum, the gastrocolic ligament or the transverse mesocolon. If perforation exist, the lesser cavity will contain gas, stomach contents, or exudate in varying amounts.

A secondary perforation in a coexisting ulcer may take place several days, weeks, or even months after the primary perforation has occurred. It is to prevent this accident that a gastro-enterostomy has been advocated, but even the addition of this measure has not always accomplished this purpose.

The writer wishes also to call attention to the fact that the orifice of a small perforation may become temporarily closed through a plug of fibrine and the escape of the gastric contents delayed until the plug is dislodged. In one of Shoemaker's[105] successful cases, operated on six days after the

Digitized by Google

perforation had taken place, the perforation was closed in this way and the peritonitis was still circumscribed. Another fact of interest is that in perforations of the posterior wall of the stomach the peritonitis may be confined through the fortunate prior obliteration of the foramen of Winslow (not an uncommon condition in gastric duodenal ulcer) to the lesser cavity. In another of Shoemaker's[105] recoveries this condition was found in a patient operated on three days after the perforation had occurred.

The treatment of perforation is exclusively surgical, and consists in the closure of the perforation with or without a partial or complete excision of the ulcer proper. Complete excision is of value in small perforating ulcers in any accessible portion of the stomach or duodenum, when the resulting gap can be easily closed without undue tension. Excision is of special value if closure of the perforation by suture is impossible because of the friability of the tissue through which the sutures must pass. On the other hand the closure of gaps after excision of large ulcers may be difficult, and the lumen of the viscus, especially in the pyloric and duodenal zones, unduly narrowed. In cases of this character, as a substitute for excision the perforation can be closed satisfactorily by the superposition of an adjacent viscus, preferably of the gall-bladder as has been done by Bessel-Hagen[98a] and Downes,[20] or by the apposition and suture of an omental flap over the weakened area, as has been done by Braun[12] and Gibbon. The plugging of the orifice of the perforation with omentum has been followed in several instances by its necrosis and secondary perforation. As a last resort, perforations, which cannot be effectively sutured or closed in one of the ways above described, can be treated by the insertion of a tampon to the point of perforation or by the establishment of a tem-

Digitized by Google

porary gastric or duodenal fistula according to the method of Axhausen[5] or Neumann,[92] in which a rubber catheter first inserted through the perforation is subsequently surrounded by a funnel of omentum, forming a channel through which the contents of the duodenum may escape or food be introduced without incurring the risk of invasion of the general peritoneal cavity. Perforations which cannot be found may be treated by tampon or by a gastro-enterostomy, to which reference has already been made. F. Brunner[16] collected 15 cases in which the perforation was treated by the insertion of a tampon, with only three deaths. In the majority of these cases a gastric fistula formed which subsequently closed spontaneously. On the other hand, in Petrén's[102] much more valuable table of 93 cases, only three of 39 cases treated by tampon recovered, against 28 of 61 treated by suture which recovered, a result which leads Petrén to emphasize the undesirability of this method of treatment.

In regard to the excision of a perforating ulcer, the argument has been advanced that by this method the ulcer is definitely removed and therefore the risk of a recurrence of a perforation or of subsequent hemorrhage made impossible. It is necessary, however, to remember that excision of a perforation can, in no way, influence the course of a coexisting ulcer nor prevent either perforation or hemorrhage from taking place at such a point. As a matter of fact, simple suture of a perforation seems to be followed by as complete a cure of the affected ulcer as is accomplished by its excision. Evidence to demonstrate this fact is furnished by the interesting cases of Morton,[90] Fenwick,[34] and Marnoch.[74] Morton reports a case of suture of a pyloric perforation 49 hours after it had occurred. There was general peritonitis at the time of operation. The patient died three months after from

Digitized by Google

a complicating subphrenic abscess and an autopsy showed that the site of the sutured ulcer was marked by a scar and that a second perforation, shut off from the general cavity by adhesions, had taken place in a coexisting ulcer. Fenwick reports a death from general peritonitis 15 days after the suture of a perforation. Autopsy showed the ulcer to have entirely healed. Marnoch lost a case of perforation from pyæmia nine weeks after it had been closed by suture. The autopsy showed no trace whatever of the ulcer. Steinthal[108] also reports a case in which three months after the suture of a perforation plus gastro-enterostomy, the patient died from a subphrenic abscess. The autopsy showed that the ulcer had entirely healed. Moreover, in perforations treated by suture, subsequent perforation or hemorrhage, rare as it is, does not usually take place at the point of suture, but from some coexisting ulcer. Finally, it must be remembered that excision can in no way remove the cause of ulceration whatever that may be, and that after successful excision, through the formation of new ulcers the patient may again be subjected to the risk of perforation, hemorrhage, or any other serious complication.

Whether the particular method of suture contributes in any way to the ultimate healing of an ulcer in which the perforation has been merely closed cannot be definitely stated, but it is quite conceivable that the purse-string suture, although it does not completely penetrate the wall of the stomach, may modify the circulation of the included segment to such an extent as to replace the ulcer with a healthy granulating surface which quickly heals, while the security of the sutured area is insured by one or more reinforcing Lemberts.

After the closure of the perforation, the adjacent part of the peritoneal cavity should be carefully cleaned. This can

Digitized by Google

be done either by dry sponging or by local irrigation, the writer preferring the latter method. In no event should evisceration be practised. In cases of general peritonitis, the cleansing of the abdomen with abundant warm saline solution seems to be most efficient. It is of the utmost importance, especially in a condition of advanced peritonitis, that the entire period of anæsthesia should be curtailed as much as possible, and accordingly the cleansing of the abdomen should in these cases be rapid rather than complete. In this connection it is well to remember that the virulency of the infectious exudate, greatest near the point of perforation, rapidly decreases as the more remote parts of the peritoneal cavity are reached. It is, therefore, essential to cleanse with the greatest care the region of the stomach and the contiguous subphrenic spaces into which, almost from the very start, stomach contents have gravitated, while less attention may be devoted to the cleansing of that part of the peritoneal cavity below the level of the transverse colon. Subsequent drainage is essential only in those cases in which it is impossible to secure adequate cleanliness. The facility with which this may be accomplished depends upon the interval between the time of perforation and that of the operation, as well as upon the character of the exudate and the quantity of stomach contents which it contains. Usually, within the first six to eight hours after perforation, the peritoneum can be so thoroughly cleaned that drainage is unnecessary. In the later cases, drainage is essential, especially of the subphrenic spaces. Apart from the immediate and frequently unavoidable peritonitis, no post-operative complication is more frequent or fatal than that of subphrenic abscess. Federmann[22] cites three deaths out of a total of seven from this cause. Of F. Brunner's[16] tabulated list of 470 cases, there were about 280 deaths,

Digitized by Google

and of these 16 gastric and 1 duodenal perforation died from this complication, while in the 92 consecutive cases reported by Petrén[102] no less than 6 of 69 fatalities were due to this cause.

As a matter of fact, the drainage of the subphrenic spaces is more difficult than that of any other part of the peritoneal cavity. Below the level of the transverse colon, drainage is unquestionably facilitated by the movement of the intestine and by the favorable action of the intra-abdominal pressure. Even of the pelvis satisfactory drainage can be provided through the suprapubic route without resorting to a counter-opening in the rectum or vagina. On the other hand, above the transverse colon and especially above the level of the stomach, the absence of the small intestine and the modified abdominal pressure, together with the fact that the subphrenic spaces are bounded in part by more or less rigid walls, make the satisfactory drainage of these places a very difficult matter. To drain them against gravity is practically impossible, and it is only by the elimination of this factor that drainage becomes possible. This fact is abundantly proved by clinical experience and may be still further substantiated by laboratory demonstration. The best method of draining the subdiaphragmatic spaces is either, one in which, by placing the patient in a suitable position, any infectious exudate or purulent material which they contain will flow toward the lower part of the peritoneal cavity and out through the abdominal incision, or by making a counteropening in the most dependent part of the affected space itself. The first method of drainage may be affected by placing the patient in the "Fowler" position, but this sometimes fails to secure the desired result, especially in corpulent subjects as well as in those patients who, on account of great weakness, find it

Digitized by Google

difficult to maintain the position for any considerable length of time. Of greater value than the Fowler position in maintaining effective drainage of the subdiaphragmatic spaces is the simple prone position. This, however, is extremely uncomfortable to the patient and cannot be assumed for any length of time without material discomfort. To obviate this objection, the writer is at present interested in the designing of a suitable bed or apparatus in which the prone position may be indefinitely maintained without complaint from the patient. If necessary, effective drainage can usually be secured by making a counteropening through the lower posterior pleural space. This operation in a patient necessarily in a weakened condition may not safely be tolerated and should therefore be done only after all other means fail. Under such conditions the operation, if successful, yields satisfactory results.

In order to determine the relative value of drains themselves experiments have been recently made in the laboratory of the hospital by my assistant, Dr. Jameson, with the following results:

1. Gauze and cigarette drains will drain only thin fluids.
2. Very tightly rolled gauze drains are not quite as good as those more loosely rolled.
3. Gauze and cigarette drains will drain the fluid from pus but none of the solid material even with the assistance of gravity or suction.
4. Lampwicks are of no value as drains.
5. The most efficient drain is a soft rubber tube with a gauze strip inside. The gauze should not fill the entire lumen.
6. Any form of suction attached to a drain improves its efficiency.

In Case XI herewith reported the drainage of both subdiaphragmatic spaces was satisfactorily accomplished with the patient in the supine position by attaching a siphon drainage apparatus to the end of two rubber tubes which passed down a distance of six and eight inches, respectively, through the epigastric incision into the right and left loin.

Digitized by Google

After the necessary cleansing and drainage of the peritoneal cavity, the question of adding a gastro-enterostomy to the measures undertaken for the closure of the perforation is one of vital interest and importance.

In the first place, there is a group of cases in which a gastro-enterostomy is urgent, namely, in those in which the closure of the perforation in whatever way it has been accomplished results in such a constriction of the pylorus or duodenum as to interfere with the passage of the gastric contents into the intestine. The writer is convinced, however, that such a contingency is very unusual and that in many cases in which a gastro-enterostomy has been done on that account, the food would have had very little difficulty in passing beyond the point of supposed constriction had the gastro-enterostomy been omitted. It must be remembered that the gastric contents pass through the pylorus and duodenum in a fluid condition, and that this is especially the case when, after gastric operations, the diet is naturally restricted for some time to fluids only. If the perforation involved an ulcer of recent formation without the encroachment of previous cicatricial tissue on the lumen of the pylorus or duodenum, it is safe to infer that any perforation could be closed by suture without the danger of subsequent constriction. Even in perforations of large size in indurated ulcers, successful closure has been accomplished without gastro-enterostomy. Thus Jopson[52] reports the successful suture of a ragged pyloric perforation admitting the gloved index-finger in the centre of an area of induration, the patient being quite well two years afterward. On the other hand, the closure of a perforation in an old callus ulcer, which in itself has led to considerable previous cicatricial contraction, may so diminish the lumen of the viscus as to make a gastro-enterostomy necessary. The writer recalls

Digitized by Google

one instance, however, in which, after a history of more than 20 years, a greatly emaciated patient (and yet not complaining of the subjective symptoms of starvation) was admitted to the hospital with a diagnosis of carcinoma. Subsequent examination showed a condition of chronic ulceration of the pyloric and duodenal junction with cicatricial stenosis so advanced that for a distance of at least one inch the lumen of the intestine was only sufficiently large to admit a lead-pencil. This advanced lesion had been of slow formation, and it is quite conceivable that, had it been of more rapid development, acute obstruction would have ensued. That such extreme stenosis does not necessarily interfere with the passage of gastric contents into the intestine in quantity sufficient to maintain life, is certainly worthy of comment. In this connection it is of interest to note how great a degree of constriction of the first part of the duodenum can be produced without primarily interfering with the passage of food or secondarily leading to compensatory hypertrophy, with or without dilatation of the stomach.

In order to investigate this question, nine cats were operated upon, of which one died of peritonitis caused by leakage and two others from diseases not connected with the digestive tract. In the remaining six the method employed was to excise from one-quarter to two-thirds of the circumference of the duodenum, suture the gap, and allow the cats to live six months.

Following the operation, all the cats showed progressive improvement and gain in weight, variations being directly traceable to external influences. Two cats vomited on the day after operation, and one other refused most of its food for a week.

At the end of six months examination of the removed specimens showed a negligible enlargement of those stomachs where two-thirds of the circumference of the duodenum had been removed. The duodenum showed only a slight constriction at most, and in those cases where small amounts were excised none whatever. Some difficulty was experienced in locating the spot where the excision had been made because of the comparatively normal appearance of the duodenum. There was in some cases a puckering of the mucosa and slight induration at the site of the scar. Microscopically, exami-

Digitized by Google

nation revealed in two cases complete regeneration of epithelium and in a third a covering of degenerated epithelium.

Conclusions: It is not possible in the cat by partial excision of the wall of the duodenum to produce a permanent marked constriction of its lumen or a resulting dilatation of the stomach.

In the cat the duodenal wall is so thick as compared with the diameter of the bowel that after removal of two-thirds of the circumference of the duodenum so little mucous membrane remained that suture of the edges of the opening was extremely difficult. Notwithstanding this immediate constriction produced by the operation, the wall subsequently stretched sufficiently to make the diameter of the duodenum practically uniform.

Doctor W. G. MacCallum (personal communication), in attempting to produce partial pyloric obstruction in dogs has had a similar experience.

Subject	Weight at operation	Amount removed	Weight after six months	Degree of dilatation of stomach	Degree of construction of duodenum	Appearance of site of excision	Microscopy
	Gm.		Gm.				
1	2720	2/3	3900	Very slight	Very slight	Induration puckering	Specimen preserved.
2	2050	1/4	3020	"	"	Negative	
3	2280	1/2	3850	"	Very slight	Negative	
4	1900	2/3	2250	Slight	Slight	Groove in mucosa	
5	2420	1/3	3400	"	Very slight	Induration puckering	Covering of normal epithelium
6	2880	2/3	3680	"	Slight	Induration	Covering of partly degenerated epithelium

All the cats were in poor condition when received.

A second group includes those desperate or neglected cases in which there is an advanced peritonitis at the time of operation. The most enthusiastic champion of gastro-enterostomy after closure of a perforation would unquestionably concede the propriety of its omission under such circumstances.

A third group includes all cases in a favorable condition in which closure has been accomplished without undue constriction and in which there is no advanced peritonitis. The adherents of a gastro-enterostomy in cases of this character

Digitized by Google

advance the following arguments for its performance. They believe that it is of immediate benefit in that it (*a*) prevents undue tension on the closed perforation and thereby obviates the danger of the yielding of the suture; (*b*) that it diminishes the danger of perforation in coexisting ulcers; (*c*) that it diminishes the risk of hemorrhage from coexisting ulcers; (*d*) that it increases the probability of the healing of coexisting ulcers; (*e*) that it favors the early and prompt post-operative nutrition of the patient; (*f*) that it may prevent the further escape of gastric contents from a perforation which cannot be located by providing means of their rapid and direct passage into the intestine.

They further assert that its benefit is lasting and permanent in that (*a*) it prevents the remote perforation of coexisting ulcers; (*b*) that it forestalls the effect of cicatricial contraction and the consequent stasis of food. In other words, that it has the same beneficial effect as a gastro-enterostomy which is done in the absence of a perforation.

On the other hand, the arguments advanced by many observers against a gastro-enterostomy may be grouped as follows: (*a*) it prolongs an operation which is one of emergency and which it is always desirable to conclude in the shortest possible time; (*b*) that it subjects the patient to the added risk of infection of the lesser peritoneal cavity; (*c*) that patients in whom a gastro-enterostomy is done are not always relieved of their gastric symptoms; (*d*) that patients treated by suture only frequently suffer from no recurrence of their symptoms; (*e*) that in those cases of perforation treated by suture only, in which the symptoms of gastric ulcer either persist or recur, a gastro-enterostomy can be done more safely than at the time of perforation; (*f*) that patients in whom a gastro-enterostomy is added to the closure of a perforation are

Digitized by Google

subjected to the risk of a subsequent peptic ulcer in the jejunum.

These different arguments in favor of and against a gastro-enterostomy are worthy of a most careful consideration.

In regard to the possibility of the yielding of the suture in those cases where a gastro-enterostomy is omitted, it may be said that, theoretically, the occurrence of more or less powerful muscular contraction in a moderately distended stomach ought to result in the tearing out of the suture and the recurrence of the perforation. As a matter of fact, however, experience shows that this accident rarely if ever occurs, and in those patients who die from peritonitis or other cause the autopsy frequently records the fact that the sutures closing the perforation are intact. Thus in Brunner's[16] extensive statistics no mention of the giving way of a sutured perforation occurs, although he refers to 12 cases in which a fatal issue resulted from the perforation of a coexisting ulcer on an average of eight days after the original perforation had been closed. Furthermore, a search of Petrén's[102] histories shows 13 instances in which in the autopsy findings the definite statement is made that the sutures had held, while in only one the sutures are reported to have given way. In this instance the original perforation had been found after considerable difficulty on the posterior surface of the stomach near the cardia and the orifice "was closed as well as possible." Evidently the perforation had proved relatively inaccessible and its closure correspondingly defective. The giving way of the sutures has never taken place in the writer's experience, and if closure of the perforation is made with a purse-string suture reinforced by at least two Lemberts the writer believes it is unlikely to occur. If the security of the suture is endangered through the friability of the adjacent tissue, it can readily be

Digitized by Google

strengthened by the superposition of an omental flap, a procedure otherwise unnecessary and having the disadvantage of predisposing to secondary ileus.

Gastro-enterostomy probably diminishes the danger of the perforation of coexisting ulcers by facilitating the passage of the gastric contents into the intestine. F. Brunner[16] mentions 12 perforations of this character occurring within one month after the suture of the primary perforation. On the other hand, the fact that an added gastro-enterostomy does not necessarily protect against perforation is demonstrated by the cases reported by Shoemaker[105] and Dahlgren[24] (two cases). Furthermore, it is a well-known fact that perforation may occur in stomachs after a previous gastro-enterostomy for ulcer, either at the point of anastomosis or in some remote portion. Eight instances of such perforation, collected from the literature, were reported by the writer in his previous paper, and, one more, reported by Petrén,[102] must be added to this number.

That a gastro-enterostomy added to the closure of a perforation diminishes the probability of subsequent hemorrhage from coexisting ulcers is quite untenable. F. Brunner[16] reports eight cases of this character after the closure of perforation by suture and to this number must be added one reported by Wallis,[117] one by Heussler,[45] and three by Petrén.[102] On the other hand, three instances of this accident occurring in cases in which simultaneous gastro-enterostomy was done, reported by Steinthal,[108] Mühsam,[86] and Dahlgren,[26] may be cited.

Additional testimony adverse to the efficacy of gastro-enterostomy in protecting patients against this accident is furnished by the experience of Kregius,[59] Küttner,[68] and Albrecht.[124] Kregius reports three cases in one of which secondary hemorrhage occurred six days after a posterior gastro-enterostomy

Digitized by Google

and two cases in which this accident was fatal one day and three weeks respectively after an anterior gastro-enterostomy with entero-anastomosis. Küttner reports two cases in which a fatal hemorrhage occurred one day and three weeks respectively after a gastro-enterostomy, of which the type is not mentioned. Albrecht also reports two cases in which hemorrhage led to a fatal issue two and three days after an anterior gastro-enterostomy with entero-anastomosis and a posterior gastro-enterostomy respectively.

That a simultaneous gastro-enterostomy increases the rapidity with which coexisting ulcers heal is necessarily conjectural. Although it is quite probable that the healing of coexisting ulcers in the pyloric and duodenal zones is thereby hastened, other ulcers between the gastro-enterostomy orifice and the cardia could be favorably affected only through the diminution or prevention of hyperacidity.

That simultaneous gastro-enterostomy permits earlier feeding of the patient than in those cases in which the perforation is merely closed would not be granted by many observers. In the early days of gastro-enterostomy, the question of post-operative feeding was approached with fear and trembling. At present the general custom is to give small quantities of food by mouth as early as 15 to 20 hours after operation, and if tolerated, this amount is rapidly increased. The writer has adopted a precisely similar method of feeding in cases of perforation and has never seen an accident after its use. Only in those cases in which the security of the sutured perforation may be insecure through tissue friability is special caution necessary, and as has already been mentioned, even then the sutures are not likely to give way. To show the time at which the post-operative feeding is begun the writer has taken the

Digitized by Google

following extracts from the histories of the cases reported in his previous paper and those reported now for the first time:

CASE I: Perforation anterior wall three inches from the cardia; 1903. Albumin, water, and kumyss at the forty-eighth hour.

CASE II: 1904; perforation on the anterior surface of the pylorus. Peptonized milk on the fourth day.

CASE III: 1905; duodenal perforation. Water and kumyss three and one-half days after perforation.

CASE IV and V: No record.

CASE VI: 1907; duodenal perforation. Full fluids the twenty-fourth hour.

CASE VII: 1907; duodenal perforation. Water, broth and beef tea at the thirty-sixth hour.

CASE VIII: 1908; duodenal perforation. Sips of water sixteenth hour. Fluids without milk thirty-sixth hour.

CASE IX: 1910; pyloric perforation. Small quantity of water fourteenth hour; Lenhartz diet thirty-sixth hour.

CASE X: 1910; pyloric perforation. Ice and water fourteenth hour. Lenhartz diet sixtieth hour.

CASE XI: 1911; pyloric perforation. Hot water fourteenth hour. Milk and brandy thirty-eighth hour.

CASE XII: 1911; gastric perforation near pylorus; treated as in Case XI.

A careful consideration and analysis of the preceding facts seem to indicate that, on the whole, the immediate advantages of supplementing the suture of a perforation with a gastro-enterostomy are at best but very slight and not at all likely to contribute materially to the patient's recovery.

The suggested advantages of gastro-enterostomy are also those of jejunostomy advocated by Von Eiselsberg,[115] except for the fact that while the benefit of a jejunostomy consists only in permitting the early resumption of feeding the patient, a gastro-enterostomy, if the anastomosis be of sufficient size, may benefit permanently as well. With the closure of the jejunal fistula, the stomach is in precisely the same condition as if the operation had been restricted merely to the closure of the perforation.

Digitized by Google

Of the permanent benefits gained by adding a gastro-enterostomy to the closure of a perforation, it is stated that by preventing recurrence of ulceration it at the same time necessarily prevents a remote recurrence of the perforation. Four cases, collected from the literature, of remote perforation after simple suture of a primary perforation in which this accident might have been prevented by a simultaneous gastro-enterostomy were reported by the writer in his previous paper, and to these must be added the case reported by French,[85] in which the recurrence of the perforation took place four years after the primary suture, and the case reported by Mitchell,[82] recurring at the same site some months after the original operation. That such a relapse is not impossible when a gastro-enterostomy is added to the closure of perforation, is demonstrated by the case reported by Petrén,[102] in which, nine months after the suture of a perforation plus a posterior gastro-enterostomy, a perforation recurred at the site of anastomosis.

Moreover, that gastro-enterostomy will not always prevent perforation is well demonstrated by the cases of remote perforation occurring after gastro-enterostomy for simple ulcer uncomplicated by perforation. Thus the writer collected from the literature and reported in his previous paper eight perforations of this character at some point in the stomach remote from the anastomosis and three others occurring at the anastomosis. To these must be added the case reported by Morton,[90] in which the patient suffered from two attacks of perforation at the point of anastomosis months after the original gastro-enterostomy.

Probably one of the strongest pleas in favor of adding a gastro-enterostomy to the closure of a perforation is that such a measure affords permanent relief from the persistence or recurrence of ulcer symptoms. The writer has succeeded in

Digitized by Google

collecting 36 cases in which the persistence of symptoms after the simple closure of a perforation demanded a gastro-enterostomy for their relief. Two others must be added to this number, observed by the writer himself. In one of these, Case III reported in the previous paper, the patient remained well for three and one-half years after the closure of the perforation. The symptoms of ulcer then recurred, and at the end of two years a gastro-enterostomy was done in a German hospital, since which time the patient has been in perfect health.

In the second case a duodenal perforation had been closed by suture and an omental flap; months afterward, the patient having been perfectly well in the interval, symptoms indicating pyloric obstruction with gastric stasis developed and were completely relieved by a posterior gastro-enterostomy.

In all of these cases of gastro-enterostomy at the time of closure of the perforation would probably have obviated a second operation, but it is quite questionable in the writer's opinion whether under these circumstances the operations for the perforation would have resulted without mortality.

As a matter of fact, an analysis of the cases requiring secondary gastro-enterostomy shows that the interval between the primary closure of the perforation and the secondary gastro-enterostomy, even when only eight or nine days, was sufficient to permit of the patient's recovery from the effect of the primary operation as well as to allow for the subsidence of the peritonitis—facts to which could be ascribed in part at least the absence of mortality associated with the secondary gastro-enterostomy.

Two exceptions to these favorable results occur in the case reported by French,[35] in which after the plication of the peritoneum to form a channel from the abdominal wall to an inaccessible perforation near the cardia, the symptoms of the ulcer

Digitized by Google

persisted and were not relieved either by separation and division of the adhesions or by a subsequent gastro-enterostomy, and in the case reported by Petrén[102] of suture for a perforation on the anterior wall of the stomach followed by suppuration in the abdominal wall. The gastric symptoms persisted and at the end of two years the patient consented to a posterior gastro-enterostomy, which was done without benefit.

The table of cases requiring subsequent gastro-enterostomy for the persistence of gastric symptoms might well be supplemented by another, comprising cases in which the persistence of gastric symptoms warranted a gastro-enterostomy, to which, however, the patients would not consent. Of these, 13 were collected and reported by the writer in his previous paper.[80]

SUTURE FOLLOWED BY SECONDARY GASTRO-ENTEROSTOMY.

(*a*) Ten successful cases, cited in previous paper.

(11) Cuff:[105] Anterior gastro-enterostomy six weeks after suture of ulcer.

(12) Steinthal:[106] Posterior gastro-enterostomy for colica anterior three years after original perforation.

(13) ——: Posterior gastro-enterostomy eight weeks after because of recurrent symptoms.

(14) Dege:[100] Gastro-enterostomy on ninth day on account of pyloric obstruction.

(15) Mitchell:[82] Gastro-enterostomy eight days after on account of duodenal obstruction.

(16) Shoemaker:[105] Gastro-enterostomy two months after perforation for belching and gastric pain.

(17) ——: Four weeks after perforation; gastro-enterostomy for retention symptoms of two weeks.

(18) Moynihan:[85] Several months after perforation, gastro-enterostomy for stenosis.

(19) ——: Several months after perforation, gastro-enterostomy for stenosis.

(20) ——: Four years after perforation, hour-glass stomach found.

(21) Mayo:[75] Details not mentioned.

(22) Marnoch:[74] Details not mentioned.

(23) ——: Details not mentioned.

(24) Carwardine:[39] Details not mentioned.

(25) ——: Details not mentioned.

Digitized by Google

(26) Battle:[7] Anterior gastro-enterostomy two months after perforation. Peptic ulcer 22 months.

(27) ——: Anterior gastro-enterostomy 12 months after perforation.

(28) Allaben:[4] Posterior gastro-enterostomy three weeks after perforation for stenosis. Nineteen months after gastric carcinoma.

(29) ——: Posterior gastro-enterostomy two months after perforation for stenosis.

(30) Morton:[90] Gastro-enterostomy six months after perforation. Hour-glass stomach found.

(31) Mitchell:[91] Gastro-enterostomy on eighth day after perforation for gastric dilatation.

(32) ——: Gastro-enterostomy eighteen months after perforation on account of stenosis.

(33) Eliot: Posterior gastro-enterostomy for stenosis three and a half years after perforation, done in Germany.

(34) ——: Posterior gastro-enterostomy seven months after suture of a pyloric perforation on account of pyloric stenosis.

(35) Miller:[127] Posterior gastro-enterostomy several weeks after the suture of a perforation on account of stenosis. Recovery.

(36) Jopson:[88] Gastro-enterostomy two years after the suture on account of the recurrence of gastric symptoms and stenosis. Recovery.

(37) Paterson:[97] No details mentioned (Lancet, 1906, p. 575).

(38) ——: No details mentioned (loc. cit.).

SUTURE FOLLOWED BY SECONDARY GASTRO-ENTEROSTOMY WHICH FAILED TO RELIEVE THE SYMPTOMS.

(*a*) French:[85] Incomplete suture of perforation near the cardia; subsequent pain not relieved by division of adhesions or a secondary gastro-enterostomy.

(*b*) Petrén:[102] Gastro-enterostomy two years after the suture of a perforation. Symptoms not relieved. Two years after gastro-enterostomy patient was still a semi-invalid.

SUTURE FOLLOWED BY PERFORATION OF COEXISTING ULCERS WITHIN ONE MONTH.

Cited by Brunner:[16] Twelve cases.

(13) (*e*) Wharton:[130] Nineteen days after closure of gastric ulcer, second perforation closed by suture of which the site is not mentioned.

(14) Ross:[125] One week after closure of duodenal ulcer recurrent perforation. Autopsy showed primary perforation closed. Recurrent perforation an inch or so away in duodenum. Four other ulcers on posterior wall of duodenum. Thinks a gastro-enterostomy at the time of original operation might have saved the man, whose condition was too desperate to permit of its being done.

Digitized by Google

SUTURE WITH GASTRO-ENTEROSTOMY FOLLOWED BY ULCERS WITHIN ONE MONTH.

(*a*) Shoemaker:[105] Twelve hours after suture with gastro-enterostomy in pyloric perforation. Place at which perforation occurred had been palpated at time of primary operation and no trace of ulcer had been found. Death.

(*b*) Dahlgren:[24] Secondary perforation twelve days after first operation.

(*c*) ——:[24] Secondary perforation fourteen days after an anterior gastro-enterostomy with entero-anastomosis, gastrostomy, and typhlostomy in site of original perforation.

SUTURE FOLLOWED BY REMOTE PERFORATION.

(*a*) Cited in previous paper four cases.

(*b*) French:[66] One case four years after excision and suture.

(*c*) Mitchell:[82] One case recurring in same site (duodenum) eight months after suture.

(*d*) Andrew:[3] Perforation on posterior surface six months after suture of one on anterior surface of which there was no trace.

(*e*) Peck:[90] One year after suture duodenal ulcer.

SUTURE WITH GASTRO-ENTEROSTOMY FOLLOWED BY REMOTE PERFORATION.

(*a*) Petrén:[102] Suture with posterior gastro-enterostomy followed two days later by entero-anastomosis on account of threatened vicious circle. Nine months later perforation at site of anastomosis. Operation. Recovery.

(*b*) Wharton:[130] Suture with gastro-enterostomy by Deaver.[37] One year later perforation closed by Wharton. One year later a third perforation closed by Wharton.

(*c*) Maylard:[88] Suture and anterior gastro-enterostomy. Two perforations of peptic ulcers seven months and two years afterward.

SUTURE FOLLOWED BY HEMORRHAGE.

(*a*) Cited by Brunner:[16] Eight cases.

(*b*) Cited by Eliot:[30] One case.

(*c*) Wallis:[137] Hemorrhage thirty-one days after suture in case complicated on eleventh day with phlebitis and on seventeenth day with pneumonia. Death.

SUTURE WITH GASTRO-ENTEROSTOMY FOLLOWED BY HEMORRHAGE.

(*a*) Steinthal:[108] Seven days after suture with posterior gastro-enterostomy. Death.

(*b*) Mühsam:[96] Twentieth day after posterior gastro-enterostomy and suture. Ulcer diet. Recovery.

Digitized by Google

(*c*) Dahlgren:[24] Three weeks after suture with posterior gastro-enterostomy and entero-anastomosis. Death.

GASTRO-ENTEROSTOMY FOR ULCER FOLLOWED BY PERFORATION WITHIN ONE MONTH AFTER OPERATION.

(*a*) Collected in previous paper by writer, eight cases.

(*b*) Petrén:[102] Sixteen days after anterior gastro-enterostomy for ulcer. Death.

(*c*) Graf:[30] Perforation one month after gastro-enterostomy for callous ulcer of lesser curvature. Death.

(*d*) Rubritius:[106] Perforation two days after gastro-enterostomy for hour-glass stomach with ulcer on lesser curvature.

(*e*) Collinson:[33] Perforation of jejunal ulcer thirteen days after gastro-enterostomy for duodenal ulcer. Death.

(*f*) Hamann:[41] Perforation of jejunal ulcer twenty-six days after gastro-enterostomy. Death.

GASTRO-ENTEROSTOMY FOR ULCER FOLLOWED BY REMOTE PERFORATION.

(*a*) Collected by writer in previous paper, eight cases remote from site of anastomosis.

(*b*) Petren:[103] Four months after posterior gastro-enterostomy at point remote from anastomosis. Recovery.

(*c*) Busch:[17] Seven months after posterior gastro-enterostomy of a pyloric ulcer.

(*d*) Morton:[99] Three and a half months after gastro-enterostomy occurring at junction. Repeated three and a half months later.

(*e*) Three cases cited by author in previous paper occurring at anastomosis.

(*f*) Moreau:[94] Perforation of ulcer at site of gastro-enterostomy done seven years before.

GASTRO-ENTEROSTOMY FOR ULCER FOLLOWED BY HEMORRHAGE.

(*a*) Krogius:[89] Six days after posterior gastro-enterostomy. Death.

(*b*) Three weeks after anterior gastro-enterostomy with entero-anastomosis. Death.

(*c*) Krogius:[89] One day after anterior gastro-enterostomy with entero-anastomosis. Death.

(*d*) Küttner:[64] Two cases, one day and three weeks after gastro-enterostomy, type not mentioned.

(*e*) Borszeky:[13] One case, fatal four hours after gastro-enterostomy from peptic ulcer of œsophagus; one case, fatal twelve days after gastro-enterostomy from peptic ulcer of œsophagus.

(*f*) Dahlgren:[24] One case died eight days after gastro-enterostomy from an ulcer of the body eroding the splenic artery; one case died four days

Digitized by Google

after gastro-enterostomy from an ulcer of the body eroding an artery in the pancreas; one case died thirty-six hours after gastro-enterostomy from an ulcer of the duodenum eroding the portal vein.

(*g*) Hofmann:[48] One case of fatal hemorrhage twenty-nine days after gastro-enterostomy for callous gastrohepatic ulcer.

(*h*) Kreuzer:[88] One case of fatal hemorrhage from a pyloric ulcer two days after gastro-enterostomy.

(*i*) Kramer:[97] One case of fatal hemorrhage from pyloric ulcer twenty-five days after gastro-enterostomy.

(*j*) Lambotte:[98] One case of severe hemorrhage immediately after gastro-enterostomy. Recovery.

(*k*) Mayer:[77] One fatal case seven days after gastro-enterostomy for hour-glass stomach; one fatal case eight days after gastro-enterostomy for pyloric obstruction (jejunal ulcer); one fatal case ten days after gastro-enterostomy for multiple ulcers.

(*l*) Rubritius:[108] One fatal case ten days after gastro-enterostomy for hour-glass stomach; one severe case immediately post-operation. Relaparotomy and ligature of bleeding vessel in gastro-enterostomy wound. Recovery.

(*m*) Vautrin:[113] Two cases of bleeding duodenal ulcer died respectively one and two days after gastro-enterostomy.

(*n*) White:[120] One case died shortly after gastro-enterostomy for gastric ulcer.

(*o*) Mayer:[77] One case of fatal hemorrhage one year after gastro-enterostomy for ulcer, site not stated; one case of ulcer of the body died three months after gastro-enterostomy of acute inanition accompanied by vomiting of blood.

(*p*) Schulz:[106] One severe case sixteen months after gastro-enterostomy for pyloric ulcer.

(*q*) Vautrin:[113] One severe case fifteen months after gastro-enterostomy for bleeding ulcer.

(*r*) Dahlgren:[34] One case of ulcer of the body had severe hemorrhages ten days after gastro-enterostomy and frequently after the second year until lost sight of in the eighth year.

(*s*) Deaver:[27] One case died of inanition with blood in the stools two months after gastro-enterostomy.

(*t*) Hofmann:[48] One case of repeated severe hemorrhages beginning in the second year post-operation and lasting over a period of five years.

(*u*) Kreuzer:[88] One case of severe hemorrhage thirteen months after gastro-enterostomy for florid pyloric ulcer.

(*v*) Kramer:[97] One case of fatal hemorrhage from an ulcer at the site of a gastro-enterostomy, occurring fourteen days after a resection done because of repeated hemorrhages following the gastro-enterostomy.

Digitized by Google

GASTRO-ENTEROSTOMY FOR ULCER FOLLOWED BY CARCINOMA.

(*a*) Graf:[30] Four and one-half years after posterior gastro-enterostomy with button, carcinoma of the stomach with glandular metastasis.

(*b*) Allaben:[3] Carcinoma nineteen months after a posterior gastro-enterostomy.

(*c*) Bamberger:[6] In his voluminous statistics finds carcinoma in two per cent.[30] of cases developing in old ulcer after gastro-enterostomy.

GASTRO-ENTEROSTOMY AT TIME OF CLOSURE OF PERFORATION—RECOVERIES.

No. 1. Braun:[13] Closed by omental flap. Anterior gastro-enterostomy. Well three and a half years.

Nos. 2, 3. Paterson:[37] Gastro-enterostomy. Well twenty-four and fifteen months.

Nos. 4, 5. Moynihan:[25] Suture and posterior gastro-enterostomy.

No. 6. Brentano:[14] Suture and anterior gastro-enterostomy and entero-anastomosis. Recurrent perforation months after. Posterior gastro-enterostomy.

No. 7. Musser and Keen:[20] Operation six hours after perforation. Closure; gastro-enterostomy with Murphy button. Retention of button.

No. 8. Caird:[18] Female, 22. Operation nineteen hours after perforation. Closure and posterior gastro-enterostomy for recurrence thirteen months after primary operation.

No. 9. Caird: Male, 35. Closure and posterior gastro-enterostomy.

No. 10. Caird: Closure and posterior gastro-enterostomy on account of constriction.

No. 11. Howitt:[40] Excision, suture and anterior gastro-enterostomy. Murphy for pyloric.

No. 12. Noetzel:[24] Male, 31. Operation nine hours after perforation. Excision, suture and posterior gastro-enterostomy. Patient well two and a half years.

No. 13. Noetzel: Male, 33. Operation forty hours after perforation. Excision, suture for pyloric.

No. 14. Noetzel: Male, 25. Excision, suture for pyloric. General peritonitis.

No. 15. Haim:[40] Female, 70. Operation five hours after perforation. Closure and posterior gastro-enterostomy for pyloric. Suture constriction.

No. 16. Korte:[34] Posterior gastro-enterostomy, dilatation of the stomach.

No. 17. Brentano:[14] Posterior gastro-enterostomy, thickening of pylorus.

No. 18. *Ibid.:* Posterior gastro-enterostomy, callus edges of ulcer.

Nos. 19, 20. *Ibid.:* Posterior gastro-enterostomy, suture constriction.

No. 21. Hartwell:[42] Closure and posterior gastro-enterostomy, Murphy, suture constriction.

Digitized by Google

No. 22. Brewer:[16] Closure and posterior gastro-enterostomy for recurrent perforation.

No. 23. Martin:[59] Closure and posterior gastro-enterostomy, Murphy, suture constriction.

No. 24. Petrén:[102] Operation six and a half hours after perforation. Excision, suture, anterior gastro-enterostomy, anterior colica (?) and entero-anastomosis.

No. 25. *Ibid.:* Operation eleven hours after perforation. Excision, suture, posterior gastro-enterostomy, entero-anastomosis. Third day for vicious circle.

No. 26. Steinthal:[106] Operation two hours after perforation. Suture and posterior gastro-enterostomy for perforation near pylorus.

No. 27. *Ibid.:* Operation four hours after perforation. Suture and posterior gastro-enterostomy for perforation near pylorus.

No. 28. *Ibid.:* Operation twelve hours after perforation. Suture and posterior gastro-enterostomy for perforation near pylorus.

No. 29. *Ibid.:* Operation seven hours after perforation. Suture and posterior gastro-enterostomy for perforation near pylorus.

No. 30. Muhsam:[66] Operation twelve hours after perforation. Suture and posterior gastro-enterostomy for perforation near pylorus.

No. 31. *Ibid.:* Operation three hours after perforation. Suture and posterior gastro-enterostomy for perforation near pylorus. Recovery complicated by bloody stool twentieth day.

No. 32. *Ibid.:* Operation three hours after perforation. Suture and posterior gastro-enterostomy for upper pyloric perforation.

No. 33. *Ibid.:* Operation twelve hours after perforation. Suture and posterior gastro-enterostomy (Murphy) for perforation duoden, pyloric.

No. 34. *Ibid.:* Operation twenty-two hours after perforation. Suture and anterior gastro-enterostomy, anterior colica (?); perforation upper posterior pylorus.

No. 35. Kroiss:[62] Operation twenty-eight hours after perforation. Suture and posterior gastro-enterostomy, Murphy. Complication thrombosis.

No. 36. *Ibid.:* Operation eighteen hours after perforation. Posterior (?) gastro-enterostomy, anterior colica, Murphy. Mesocolon contracted.

No. 37. *Ibid.:* Operation twenty-one hours after perforation. Posterior gastro-enterostomy, Murphy. Pylorus probably closed.

No. 38. Blake:[11] Operation four hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation.

No. 39. Murphy:[67] Operation nine hours after perforation. Suture and posterior gastro-enterostomy, suture constriction.

Nos. 40, 41, 42. Moynihan:[65] No details given.

Nos. 43, 44, 45. Mayo:[73] Suture and posterior gastro-enterostomy.

No. 46. Morton:[69] Details not given.

No. 47. McWilliams:[73] Operation six hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation.

Digitized by Google

No. 48. *Ibid.:* Operation twelve hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation.

No. 49. *Ibid.:* Operation seven hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation.

No. 50. Downes:[39] Posterior gastro-enterostomy and overlapping of the gall-bladder, pyloric.

No. 51. Harrison:[46] Suture and posterior gastro-enterostomy anterior wall. Empyema and fecal fistula.

No. 52. Carwardine:[39] No details.

No. 53. *Ibid.:* No details.

No. 54. Maylard:[39] Suture and anterior gastro-enterostomy. Seven months later perforation, peptic ulcer one and a half inches below anastomosis. Two years later perforation in efferent jejunum close to mesentery one inch below.

No. 55. Finsterer:[39] Operation ten hours after perforation. Suture and posterior gastro-enterostomy, suture stenosis.

No. 56. Noall:[39] Operation forty-two hours after perforation. Suture and posterior gastro-enterostomy for duodenal perforation.

No. 57. Woolsey:[228] Operation six hours after perforation. Suture and posterior gastro-enterostomy for perforation near pylorus.

Nos. 58, 59, 60, 61. Mitchell:[91] All within fifth hour, posterior gastro-enterostomy. No details.

No. 62. *Ibid.:* Operation four hours after perforation. Anterior gastro-enterostomy (fat mesocolon) for recurrent duodenal perforation.

No. 63. Pernitza:[161] Operation six hours after perforation. Suture and posterior gastro-enterostomy, suture constriction, anterior pylorus.

No. 64. Krogius:[39] Operation three hours after perforation. Suture and posterior gastro-enterostomy, suture constriction, anterior pylorus.

No. 65. Milko:[81] Operation three hours after perforation. Gastro-enterostomy, marked pyloric stenosis, later entero-anastomosis, vicious circle.

No. 66. Stirling:[230] Operation nine hours after perforation. Suture and posterior gastro-enterostomy, pyloric stenosis.

Nos. 67, 68. Lundblad:[230] Suture and posterior gastro-enterostomy, Murphy for pyloric perforation.

No. 69. Kronlein:[61] Operation five hours after perforation. Suture and posterior gastro-enterostomy and entero-anastomosis for pyloric perforation.

No. 70. *Ibid.:* Operation five hours after perforation. Suture and posterior gastro-enterostomy and entero-anastomosis for duodenal perforation.

No. 71. Van Khautz:[116] Operation six hours after perforation. Suture and posterior gastro-enterostomy for pyloric ulcer with induration.

No. 72. *Ibid.:* Operation three hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation.

No. 73. Locone:[39] Operation six to twelve hours after perforation. Suture and posterior gastro-enterostomy for perforation on lesser curvature.

Digitized by Google

No. 74. *Ibid.:* Operation six to twelve hours after perforation. Suture and posterior gastro-enterostomy for perforation on lesser curvature.

No. 75. *Ibid.:* Operation six to twelve hours after perforation. Suture and posterior gastro-enterostomy for duodenal perforation.

No. 76. Dandelski:[39] Operation four hours after perforation. Suture and posterior gastro-enterostomy for perforation anterior pylorus.

No. 77. Sonnenburg:[107] Operation thirty hours after perforation. Suture and posterior gastro-enterostomy and omental flap for callous pyloric. Murphy.

No. 78. Nordmann:[68] Operation six hours after perforation. Excision, suture and posterior gastro-enterostomy for perforation induration, lesser curvature.

No. 79. *Ibid.:* Operation two hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation complicated by pneumonia.

No. 80. Hofmeister:[47] Operation twenty hours after perforation. Suture and posterior gastro-enterostomy for perforation duodenum.

No. 81. Mennier:[79] Operation twenty hours after perforation. See Kroiss table. Reference not found.

No. 82. Ward:[218] Operation six hours after perforation. See Kroiss table. Reference not found.

No. 83. *Ibid.:* See Kroiss table. Reference not found.

No. 84. Wickerhauser:[220] Operation four and three-quarter hours after perforation. See Kroiss table. Reference not found.

No. 85. Falkenburg:[31] Operation twenty hours after perforation. From Kroiss table. Reference not given.

No. 86. Körte:[60] Suture and posterior gastro-enterostomy, suture constriction.

No. 87. Brentano:[24] Suture and posterior gastro-enterostomy, suture constriction.

No. 88. Petrén:[102] Operation eight hours after perforation. Suture and gastro-enterostomy, anterior colica (?) anterior for duodenal perforation.

No. 89. Blake:[11] Male, 31. Operation three hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation in induration ulcer.

GASTRO-ENTEROSTOMY AT TIME OF CLOSURE OF PERFORATION—FATALITIES.

No. 1. Moynihan:[86] Details not given.

No. 2. Caird:[18] Female, 37. Operation seventeen hours after perforation. Suture and posterior gastro-enterostomy for large pyloric perforation; suture constriction.

No. 3. *Ibid.:* Female, 31. Operation ten hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation; suture constriction.

Digitized by Google

No. 4. *Ibid.:* No details; posterior gastro-enterostomy necessary from suture constriction.

No. 5. *Ibid.:* No details; posterior gastro-enterostomy necessary from suture constriction.

No. 6. Miles:[80] Male, 49. Suture and posterior gastro-enterostomy for thickened pyloric perforation.

No. 7. *Ibid.:* Suture and posterior gastro-enterostomy for duodenal perforation; suture constriction.

No. 8. Noetzel:[84] Male, 23. Operation seventy-two hours after perforation. Excision, suture and omental flap for pyloric perforation, posterior gastro-enterostomy.

No. 9. *Ibid.:* Male, 65. Operation three hours after perforation. Suture and omental flap for pyloric perforation, Murphy posterior gastro-enterostomy.

No. 10. Körte:[85] Operation twenty-four hours after perforation. Suture and posterior gastro-enterostomy, suture constriction.

No. 11. *Ibid.:* Operation twenty-four hours after perforation. Suture and posterior gastro-enterostomy, suture constriction.

No. 12. Petrén:[102] Operation six hours after perforation. Suture and gastro-enterostomy for perforation. Hour-glass stomach.

No. 13. Petrén:[102] Operation one hour after perforation. Suture and gastro-enterostomy, anterior colica (?). Death from vicious circle.

No. 14. *Ibid.:* Operation twenty-three hours after perforation. Suture and gastro-enterostomy, anterior colica (?), entero-anastomosis, stenosis of pylorus.

No. 15. *Ibid.:* Operation three hours after perforation. Suture imperfect for perforation on posterior pylorus, posterior gastro-enterostomy.

No. 16. Jaffe:[88] Operation sixteen hours after perforation. Posterior gastro-enterostomy, suture constriction. Death the result of gastro-enterostomy.

No. 17. Steinthal:[100] Operation six hours after perforation. Posterior gastro-enterostomy, Murphy. Death seventh day from hemorrhage.

No. 18. *Ibid.:* Operation seven hours after perforation. Posterior gastro-enterostomy. Murphy. Death three and a half months from subphrenous abscess.

Nos. 19, 20. Mayo:[73] Suture and posterior gastro-enterostomy.

No. 21. Dahlghen:[26] Suture and anterior gastro-enterostomy, entero-anastomosis for pyloric perforation. Death twelve days later from recurrent perforation.

No. 22. *Ibid.:* Death from gastric and intestinal hemorrhage three weeks after.

No. 23. *Ibid.:* No details given.

No. 24. Fensterer:[33] Operation seven hours after perforation. Suture and posterior gastro-enterostomy, pyloric-duodenal perforation, pneumonia eighth day.

Digitized by Google

No. 25. Downes:[99] Posterior gastro-enterostomy, suture constriction. Death eighth day from pneumonia.

No. 26. Van Khautz:[116] Operation three hours after perforation. Suture and posterior gastro-enterostomy for pyloric perforation.

No. 27. *Ibid.:* Operation eight hours after perforation. Suture and posterior gastro-enterostomy for posterior pyloric. Death from peritonitis.

No. 28. Borseky:[23] Operation ninety-six hours after perforation. Excision, suture and posterior gastro-enterostomy for duodenal perforation. Death six hours after.

No. 29. Leriche:[67] Operation twelve hours after perforation. Suture impossible, large callous pyloric ulcer, gastro-enterostomy with extra-peritonitis, suture of pylorus.

No. 30. Nordmann:[89] Operation twenty-four hours after perforation. Excision, edges, suture and posterior gastro-enterostomy for anterior pyloric perforation. Death sixth week after from meningitis.

A condensed tabulation of the foregoing cases gathered from the literature and from the writer's experience gives a total of 75 cases in which a gastro-enterostomy added to the closure of a perforation might have prevented the occurrence of either some further complication or the persistence of the ulcer symptoms:

After suture only: (*a*) perforation of coexisting ulcers within one month after suture of the primary perforation, 14; (*b*) hemorrhage from coexisting ulcers, 10; (*c*) remote perforations, 8; (*d*) persistence of symptoms relieved by gastro-enterostomy, 38; (*e*) persistence of symptoms indicating gastro-enterostomy, in which the operation was refused by the patients, 19.

In contrast to this table, however, is one in which gastro-enterostomy added to the closure of the perforation failed to prevent subsequent complication.

After suture plus gastro-enterostomy: (*a*) perforation of coexisting ulcers within one month, 3; (*b*) hemorrhage from coexisting ulcers, 3; (*c*) remote perforations, 15; (*d*) persistence of symptoms not relieved by secondary gastro-enterostomy, 2.

Digitized by Google

The supposed disadvantages of adding a gastro-enterostomy to the closure of a perforation have already been enumerated. In regard to the prolongation of the operation, it may be stated that in many cases, especially shortly after perforation, the general condition of the patient is such that an added gastro-enterostomy does not materially increase the risk. In other cases in which the peritonitis is advanced or virulent, the condition of the patient renders an early termination of the operation imperative, and a gastro-enterostomy should be done only in those rare instances in which the suture of the perforation closes the lumen of the gut. There are a considerable number of border-line cases, and while the writer feels that here a gastro-enterostomy, if rapidly and skilfully done, would scarcely increase the risk, yet it must be recognized that the operation is one of emergency and that these patients may fall to the lot of one relatively inexperienced in the technic of intestinal anastomosis. If this proves to be the case, the chances of recovery will be materially increased by the omission of the gastro-enterostomy. The argument frequently advanced that the addition of a gastro-enterostomy barely prolongs the operation for ten minutes should be modified by stating that only in the hands of the most experienced and skilled surgeons can this operation be completed in such a short time. As a matter of fact, the writer believes that even in skilled hands anastomosis by suture prolongs an operation for perforation by considerably more than ten minutes. Thus, in the three cases to which, through the kind permission of McWilliams, the writer refers, the total duration of closure of the perforation plus gastro-enterostomy by suture required between one hour and fifteen minutes, whereas the average time for the closure of a perforation is, in the writer's personal experience, between 20 and 40 minutes. In other words, in operations of emergency

Digitized by Google

which frequently must be done by the general surgeon rather than by the most skilled and experienced, it is unwise and even dangerous, in order to gain some slight advantage, to advocate a method of treatment which cannot generally be adopted without detriment to the patient. To be sure, if speed is essential, a gastro-enterostomy can be done with a Murphy button or other mechanical contrivance, but the opening made in this way may ultimately contract, and in that event can benefit only for as long as it remains patent. Notwithstanding the fact, however, that its benefit may not be as permanent as if a larger opening had been made by suture, its advocates assert that the opening continues patent for months if not for years, and that it not only affects favorably the immediate post-operative condition of the patient but has many of the more remote advantages of a gastro-enterostomy as well. That, however, a gastro-enterostomy added to the closure of a perforation is so markedly advantageous as its advocates maintain is not at all certain. In the preceding discussion it was shown that perforations closed without gastro-enterostomy remained as secure as those in which this measure had been added and that, in these same cases, post-operative feeding was begun as early and as safely as in cases of gastro-enterostomy for pyloric stenosis without perforation. If, then, gastro-enterostomy added to the closure of a perforation is of no immediate benefit and the remote benefit depends upon the permanence of the patency of the opening, it follows, notwithstanding the longer time required for its performance, that a gastro-enterostomy by the suture method rather than by the button or other mechanical contrivance must be the operation of choice and that, if the patient's condition does not justify the relatively longer operation, it is wiser to limit it to the mere closure of the perforation and to postpone the gastro-enterostomy until it shall

Digitized by Google

have been indicated by if at all persistent or relapsing symptoms. It is only in these rare cases in which the closure of the perforation totally occludes the lumen of the bowel and in which the general condition of the patient is such as to necessitate the shortest possible operation, that a gastro-enterostomy by the button rather than by the suture is indicated.

The second argument advanced against an added gastro-enterostomy is the possibility of its opening a direct path of infection into the lesser peritoneal cavity. This argument, based upon sound theory, has proved fallacious in actual practice. The writer has found no instance of a fatality which could be ascribed to a spread of the infectious material in this direction. In the first place, the peritoneal exudate is apt to be much less infectious below the level of the transverse colon than in the neighborhood of the perforation, while the lesser cavity proper is opened through the transverse mesocolon in its most dependent part. Furthermore, any possible spread of the infection is ordinarily prevented by carefully cleaning the site of the proposed gastro-enterostomy, while the lesser cavity itself is excluded from infection by the sutures which join the edges of the divided mesocolon to the posterior surface of the stomach.

In the next place, gastro-enterostomy for simple ulcer without perforation does not always relieve that condition even in those cases of simple ulcer in which it seems urgently indicated.

In the following tabulation of late results, there are considered, as reported by each observer, number of cases; cured; improved; not improved; died later from gastric disease; cases coming to secondary laparotomy; cases not known; and those dying of intercurrent disease.

Digitized by Google

ULCER OF PYLORUS AND PYLORIC END OF BODY

Reference	Variety	No.	Cured	Improved	Not Improved	Died	Relaparotomy	Not known	Intercurrent death	
Borszeky[23]	Ulcus callosum	5	4	..	1	..	(1)	..	..	
	Lesser curve near pelvis	1	..	..	1	..	..	..	..	
	Stenosis	12	9	..	1	..	(1)	2	..	
Clairmont[19] ...	.....	110	57	11	15	8	..	19	..	
Dahlgren[24]	Diagnosed	1	..	..	..	1	..	..	..	Died 1½ years of of carc. vent.
	Stenosis	7	5	..	1	0	..	..	1	
	Tumor	6	5	..	..	1	..	..	..	(1) Died 1 2-3 yrs. of carcinoma?
	Infiltrating	7	3	3	1	..	..	..	..	
Deaver[27]	.....	27	16	4	3	2	(2)	..	2	
Gaudemet[26] ...	.....	20	2	1	1	..	..	16	..	
Gilli[37]	Stenosis	18	12	4	1	..	(2)	1	..	
	Ulcer	2	..	1	..	..	..	1	..	
	Tumor	3	..	1	..	1	..	1	..	
Ito and Sayesima[31]	Stenosis	21	11	2	1	..	..	7	..	
Kramer[37]	Ulcer stenosis	33	19	10	4	..	..	..	..	(6 carcinoma?)
Kruzer[52]	.....	59	34	12	6	2	(4)	5	..	Died 3½ years of carcinoma?
Lambotte[68] ...	Stenosis	8	6	1	1	..	..	..	..	
	Ulcer	25	22	..	3	..	..	..	..	One case died later of secondary carcinoma.
Lieblein[70]	Stenosis	1	1	..	..	..	..	..	..	
	Callous ulcer	3	1	1	1	..	..	..	..	
Mayer[77]	Stenosis	29	12	9	2	..	..	..	6	
Nyrop[86]	Stenosis	23	14	5	3	..	..	..	1	
	Tumor	7	4	2	..	1	..	..	..	
Rubritius[100] ...	Ulcer	20	9	..	3	4	..	2	2	Four died later of carcinoma.
	Stenosis	29	14	7	4	2	(4)	..	2	
Deuechau[38] ...	Stenosis	42	12	22	8	..	..	..	..	
	Ulcer	17	5	11	1	..	..	..	..	
Graf[39]	Stenosis	23	8	8	6	..	..	..	1	
	Ulcer	16	8	4	4	..	(4)	..	..	
Hofmann[42]	.....	21	16	2	1	..	..	2	..	
Schmitt[104]	.....	25	18	6	1	..	..	..	..	
Schulz[106]	.....	36	22	7	2	2	(1)	2	1	
Stumpf[111]	.....	9	6	2	1	..	..	..	..	One week carcinoma.
Moreau[84]	.....	27	11	5	10	1	..	..	..	
		693	366	141	87	25	..	58	16	
		74						16		
		619	507 81.9%		112 18.1%			74		

Percentage of good results with operative mortality considered, 76.9.

Digitized by Google

ULCERS OF LESSER CURVATURE OF BODY DISTANT FROM PYLORUS.

Reference	Variety	No.	Cured	Improved	Not improved	Died	Relaparotomy	Not known	Intercurrent death	
Borszeky[12]	Bleeding	1	1	..	..	..	..	..	..	
Clairmont[29] ...	.....	30	9	5	9	6	..	1	..	
Dahlgren[34]	.....	7	5	1	..	..	..	..	1	
Gaudemet[36] ...	.....	8	2	3	1	2	..	..	..	
Gilli[37]	.....	8	5	3	..	..	(2)	..	..	
Kreuzer[66]	.....	4	2	2	..	..	(1)	..	..	
Lambotte[66] ...	.....	5	3	0	..	..	..	2	..	
Lieblein[79]	Callous	4	1	1	1	1	(1)	..	..	Resected specimen showed invading epithelial cells. One case died later of carcinoma.
Mayer[87]	.....	1	..	1	..	..	..	..	..	
Nyrop[96]	Tumor	6	3	2	1	..	..	..	..	
Rubritius[106] ...	.....	9	7	1	..	1	..	..	..	
Denechau[22] ...	.....	11	2	8	1	..	..	..	..	
Graf[30]	.....	14	6	..	3	2	..	3	..	
Hofmann[46] ...	.....	6	3	1	1	..	..	1	..	
Schmitt[104]	.....	6	2	4	..	..	..	..	..	
Schulz[106]	.....	8	7	1	..	..	..	..	..	
Stumpf[111]	.....	3	1	1	1	..	..	..	..	
		131	59	34	18	12		7	1	
		123	93		30			8		
			75.5%		24.5%					

Percentage of good results with operative mortality considered, 70.9.

DUODENAL ULCER.

Reference	Variety	No.	Cured	Improved	Not improved	Died	Relaparotomy	Not known	Intercurrent death	
Borszeky[12]	.....	1	1(4mo.)	..	..	..	..	..	..	
Clairmont[29] ...	.....	11	6	2	2	1	..	..	..	
Dahlgren[34]	.....	1	..	1	..	..	..	..	..	
Deaver[37]	.....	10	8	2	..	..	..	..	..	
Lieblein[79]	.....	2	1	1	..	..	..	..	..	
Nyrop[96]	.....	2	1	..	..	1	..	..	..	Carcinoma.
Schmitt[104]	.....	7	3	4	..	..	..	..	..	
		34	20	10	2	2				
		34	30		4					
			85%		15%					

Percentage of good results with operative mortality considered, 79.9.

Digitized by Google

POSITION NOT STATED.

Reference	Variety	No.	Cured	Improved	Not improved	Died	Reoperated	Not known	Intercurrent death	
Bidwell[16]	.....	81	46	21	14	..	(5)	..	..	
Busch[17]	.....	64	56	5	..	3	..	..	..	Three died of carcinoma?
Dahlgren[24]	Diagnosed	2	1	..	1	..	..	..	..	
	Bleeding	1	..	1	..	..	..	..	..	
Deaver[27]	.....	16	7	3	3	1	(1)	..	2	
Gilli[27]	.....	6	1	03	1	..	(1)	1	..	
Kuttner[28]	Ulc. callosum	12	2	1	4	5	..	..	..	Five died of carcinoma.
Gaudemet[30] ...	.....	2	1	..	..	..	..	1	..	
Mayer[17]	.....	2	..	2	..	..	..	..	..	
Nyrop[26]	.....	5	..	3	2	..	..	..	..	
Denechau[25] ...	.....	5	..	3	2	..	..	..	..	
Clairmont[19] ...	.....	6	2	2	2	..	..	..	..	
Mayer[17]	.....	2	..	2	..	..	..	..	..	
Nyrop[26]	.....	5	..	3	2	..	..	..	..	
Rubritius[166] ...	.....	1	..	1	..	..	..	..	..	
		210	116	50	31	9		2	2	
		206	166 80.5%		40 19.5%			4		

Good results with operative mortality considered, 75.6 per cent.

The above tabulation of 619 cases includes only those which have been followed for many months or years and excludes those dying immediately after the operation, those passing out of view, and those dying of intercurrent disease in whom the result of the gastro-enterostomy was still uncertain.

The operative mortality after gastro-enterostomy in the hands of the average surgeon is about 6 per cent. If we included this in our computation in order to learn the late results in all cases of gastric ulcer exclusive of perforation operated upon by gastro-enterostomy, we find the following figures: duodenal ulcer, good results, 79.9 per cent.; pyloric ulcer, good results, 76.9 per cent.; ulcer of the body distant from pylorus, good results, 70.9 per cent.; ulcers reported with the site not given, good results, 75.6 per cent.

Digitized by Google

Fourthly, a gastro-enterostomy added to the closure of a perforation does not always prevent the persistence or the recurrence of gastric symptoms. In one of the cases reported by McWilliams,[78] examination of the patient a year after the operation disclosed a condition of hyperacidity and the persistence of the same pain and digestive disturbances that the patient experienced prior to the perforation. In another case reported by the same observer, the patient without known cause had one attack similar to those prior to the perforation of a week's duration. In the third case, the result, at the end of a year, was excellent, and the patient could eat anything without difficulty.

In one case reported by Petrén,[102] an anterior gastro-enterostomy with antero-anastomosis had been added to the suture of a perforation. The patient was entirely well 16 months later. In a second case of duodenal perforation to which an anterior gastro-enterostomy had been added, the symptoms recurred within three months, and the patient had been readmitted to the medical ward of the hospital.

In the fifth place patients in whom a gastro-enterostomy is added to the closure of the perforation are quite as susceptible to the possibility of subsequent jejunal ulcer as patients operated on for pyloric stenosis without perforation. Although the writer has found no instance of this complication after gastro-enterostomy in connection with perforation, Paterson, Battle,[7] and Percy[100] have collected some 50 cases of this complication after gastro-enterostomy for ulcer.

Before dismissing the subject of the advisability of adding a gastro-enterostomy to the closure of a perforation, it may be stated, after consultation of all accessible published autopsy records, that no fatality has been found which could in any way be ascribed to the omission of that procedure. If such in-

Digitized by Google

stances are so rare, it would seem to indicate that a gastro-enterostomy must either be entirely omitted at the time of perforation and only done subsequently when indicated by relapsing or persisting symptoms, or, in order to diminish the number of cases in which such a secondary operation would be necessary, it must be left to the judgment of the surgeon to decide in each individual instance whether the added gastro-enterostomy shall be done or not. The writer believes that with satisfactory closure, or after excision and closure of a perforation, a gastro-enterostomy should be omitted in all cases of perforation of the cardiac end of the stomach, and that in perforation occurring in the pyloric and duodenal zones a gastro-enterostomy should be done only in cases of early perforation when the lesion is of such a character that a gastro-enterostomy would be indicated even although no perforation existed. In other words, that a gastro-enterostomy should be done in cases in which the extent of the cicatricial deformity would probably lead to the persistence or recurrence of gastric symptoms. In all doubtful cases the writer believes that the patient should receive the benefit of the doubt, and that the gastro-enterostomy should be deferred until the effect of the closure of the perforation shall be known. Should the symptoms of ulcer persist or a subsequent recurrence of the ulcer develop, gastro-enterostomy could be done as an operation of choice rather than as one of emergency. Under such conditions its mortality is so slight as to be practically negligible.

The arguments advanced in favor of and against adding gastro-enterostomy to the closure of a perforation indicate a wide difference of opinion as to the efficacy of this measure. This difference of opinion is shared not only by surgeons in widely separated centres but also by those in the same city and even on the staff of the same hospital. Through the great

Digitized by Google

consideration and kindness of a number of prominent surgeons on the continent and in England, who, in their publications, have shown special interest in this subject, as well as through the courtesy of my immediate colleagues on the staff of the Presbyterian Hospital of this city, the writer is enabled to quote directly the present opinion of these experienced men in regard to this important question.

Professor Krogius, of Helsingfors, has added gastro-enterostomy to the suture of a perforation in 14 out of 60 cases during the past ten years, with a total mortality of 50 per cent. He believes that a gastro-enterostomy should be done with a Murphy button in cases in which the pylorus is evidently greatly constricted, and when the condition of the patient will unquestionably stand the prolonged operation.

Professor Von Eiselsberg, of Vienna, has not changed his views published in 1907, at which time he considered a jejunostomy more advantageous than a gastro-enterostomy, especially in facilitating the post-operative nourishment of the patient.

Professor Brentano, of Berlin, has had 22 cases with a mortality of 45 per cent. Since 1902 he has added a posterior gastro-enterostomy to the closure of all perforation within the duodenal and pyloric zones. Of these he has had 16 cases with 11 recoveries. The necessary prolongation of the operation amounts seldom to more than 15 minutes, is comparatively harmless except in "cases in extremis," and is abundantly repaid by the improved conditions of nourishment during convalescence.

Dr. Petrén, of Lund, believes in adding gastro-enterostomy to the closure of a perforation only in cases in which the patient can stand the prolonged operation. The perforation should not have existed for more than 12 to 20 hours, the general condition of the patient should be good, and the heart action but slightly disturbed. Furthermore the pylorus should either be already the site of cicatricial contraction or it should be stenosed by the suture. Under these circumstances gastro-enterostomy probably increases the chances of recovery. Only a minority of those in whom the perforation has been closed without gastro-enterostomy require that operation subsequently.

Professor Noetzel, of Saarbrucken, since the publication of his paper in 1906, has had six additional cases which demonstrated: the value of adding gastro-enterostomy to the closure of a perforation in every case, irrespective of its location, and even when the closure of the perforation has not resulted in the constriction of the pylorus, for the reason that: (1) it corrects hyperacidity; (2) it makes recurrence less likely, and although it does not always succeed in preventing a fresh outbreak of the disease, it is the only measure which can be utilized for that purpose with any hope of success. He refers

Digitized by Google

to one of his unpublished cases in which, two years after the excision and suture of a perforating ulcer on the anterior wall of the stomach, the symptoms recurred and on operation by Rehn a large ulcer was found on the posterior wall. Possibly in this case had a gastro-enterostomy been done at the time of the closure of the perforation, recurrence would not have taken place. He also refers to a second unpublished case in which a condition of general peritonitis in the case of a perforation of 72 hours' standing made a speedy termination of the operation and the omission of a gastro-enterostomy imperative. Even the extensively indurated character of the ulcer, covered with fibrinous exudate, rendered an excision in healthy tissue or excision of even the edges of the ulcer impossible. The patient recovered after a suture of the perforation but repeated examinations showed a persistent hyperacidity.

Professor Noetzel also added the notes of a most interesting case in which a perforation had developed in a large ulcer on the lesser curvature, which could be treated only by a circular resection of the middle segment of the stomach according to the method of Riedel and Payr. This was carried out accordingly, the sutures, as Payr has emphasized, being inserted without difficulty. In such a case gastro-enterostomy would not be done. The patient made an excellent recovery.

Résumé: Professor Noetzel believes in adding gastro-enterostomy to the excision and closure of all cases of perforation, except where speed is essential and where the lesion is such as to demand a circular resection.

Professor Shoemaker, of The Hague, advocates gastro-enterostomy even in cases where the pylorus is stenosed only where the condition of the patient will stand the longer operation. In cases of advanced peritonitis, speed is essential and gastro-enterostomy can be added subsequently if needed. Professor Shoemaker has had four successful cases of this character. In perforations remote from the duodenal and pyloric zones, he believes that gastro-enterostomy is useless. In severe cases the perforation is closed as quickly as possible. In other cases the ulcer is first resected.

Professor Martens, of Berlin, advocates gastro-enterostomy only when the pylorus is already the site of constriction or where this results from the closure of the perforation. In other cases he believes a speedy termination of the operation of greater value than an added gastro-enterostomy.

Dr. Kroiss states that both from his former experience in the Innsbruck clinic as well as from his later experience, he is a firm believer in the advantages gained by adding a gastro-enterostomy to the closure of a perforation. He grants, however, the possibility of obtaining satisfactory results after simple suture. He refers to one recent case operated on more than 24 hours after perforation by a colleague, in which all the advantages of the added gastro-enterostomy were clearly demonstrated.

Professor Körte, of Berlin, says that the opinion which he expressed in a paper published on this subject in Langenbook's Archives (vol. lxxxiii) has been substantiated by further experience, and that he consequently regards

Digitized by Google

a gastro-enterostomy advisable: (*a*) when the perforation is located at the pylorus or its immediate vicinity in such a way that its suture or subsequent cicatricial contraction may lead to pyloric stenosis; (*b*) he also considers that it is indicated in callus perforating ulcer of the lesser curvature which threatens to result in hour-glass stomach; (*c*) it should be done, however, only in patients whose general condition is sufficiently strong to permit of prolonging the operation for 15 minutes; (*d*) after the perforation has existed for 12-16 hours, the patient's general condition is such that a gastro-enterostomy had best not be done.

Mr. Moynihan, of Leeds, writes as follows: "With regard to the performance of gastro-enterostomy in cases of acute perforating ulcer, I reserve this operation for the cases in which the closure of the ulcer causes immediate and considerable obstruction, and those in which it seems likely that, as a final result of the ulceration and of the suture, some degree of obstruction is likely to result. If the ulcer is not causing obstruction, that is, if it is on the lesser curvature or anterior wall toward the cardiac end of the stomach, I do not perform gastro-enterostomy. I have no belief whatever in the so-called 'physiological action' of gastro-enterostomy. This of course implies that the short-circuiting of an ulcer is called for in all cases of duodenal perforation, and in all cases in which the ulcer which has given way lies within an inch or two of the pylorus on the gastric side.

"The first case in which I performed gastro-enterostomy for a perforating ulcer was that recorded in the Lancet, Dec. 14, 1901—see especially page 1662, column 1. I believe it was in that paper that I was the first to advocate this operation."

Dr. W. J. Mayo, of Rochester, writes as follows: "In cases of acute perforation where the patient is in poor condition and there is a spreading peritonitis, we have closed the perforation, establishing pelvic drainage, and set the patient up in bed as a rule without irrigating the abdomen. If the patient is in fair condition, we close the ulcer by sutures and an omental graft and do a gastro-enterostomy. At one time I felt that it was better to do a gastro-enterostomy on every case of this sort, but I am convinced that I lost one case by adding the gastro-enterostomy to closure of the opening on a patient who was in poor condition."

Dr. Peck, of New York, writes as follows: "My feeling at present in regard to gastro-enterostomy at the time of closure of perforation is, that in duodenal ulcers or gastric ulcers near the pylorus where infolding by suture means probable narrowing of the pylorus, it should be done at once if the patient's condition will permit.

"In perforation of the anterior wall at a distance from the pylorus, I believe that it should not be done as a routine procedure, as in many cases it will not be needed. I have had no experience with posterior wall perforations."

The differences of opinion held by my colleagues on the staff of the Presbyterian Hospital are obvious in the following statements:

Digitized by Google

Dr. Blake believes that a gastro-enterostomy should be done when the closure of a perforation produces appreciable narrowing of the pyloric-duodenal lumen. This stenosis he is rather inclined to accentuate in the closing of the perforation.

Dr. Woolsey is inclined to do a gastro-enterostomy in duodenal perforations and in those near enough the pylorus to produce more or less stenosis.

Dr. Hawkes believes that a gastro-enterostomy is unnecessary in closure of perforations either with or without excision, unless the measure adopted causes undue constriction.

Dr. McWilliams believes that a gastro-enterostomy should be done in the cases which would stand the operation (those operated on within a few hours of the perforation). In these cases the perforation should be closed by suture which would infold the ulcerated area to the extent of practically closing its lumen. A gastro-enterostomy by suture should be done with a large stoma, at least two inches. This gives the best guarantee against the recurrence of the perforation as well as a perforation of subsequent gastric symptoms from contraction of the ulcer. This will cause very little increase in the mortality. Those perforations with marked peritonitis should not be subjected to the added strain of a gastro-enterostomy.

Dr. Hartwell believes that gastro-enterostomy is necessary if the pylorus shows a palpable narrowing with dilatation of the stomach. If the stomach is not dilated and the pylorus is not constricted, gastro-enterostomy might be omitted, but these cases are few.

The statement should be added that the members of the hospital staff were unanimous in advising a gastro-enterostomy where the suture of the perforation resulted in extensive contraction of the pylorus or duodenum, and also that a gastro-enterostomy should be omitted in all patients in whom peritonitis was advanced.

That such widely different opinions should be expressed by men of equal skill is accounted for in part, at least, by the fact that it is impossible to estimate the comparative mortality in cases treated by suture only and in those in which a gastro-enterostomy is added to the closure of the perforation. It is self-evident, if one considers the marked differences in the patient's ages, in their general condition, especially in the condition of the circulatory apparatus and the kidneys, in the virulence of the infection, in the rapidity with which the gastro-duodenal contents escape into the general peritoneal cavity, and in the duration of the perforation, that all comparison is

Digitized by Google

futile. The only other sound basis of comparison, that based upon the character of the final result, is of greater although still of uncertain value. Of the final result in cases treated by suture with gastro-enterostomy, the evidence is meagre, probably owing to the fact that this method of treatment has been in general use only during the past few years.

The following cases showing final results after this procedure have been reported in the literature:

CASE I.—Musser and Keen:[10] At the time of publication, about one and a half years after the suture of a pyloric perforation with gastro-enterostomy with Murphy button, patient still suffered from the effects of the retention of the button in the stomach.

CASE II.—Braun:[12] Patient completely well three and one-half years after the closure of a perforation in the anterior wall of the stomach by an omental flap only. Owing to the friability of the stomach wall an anterior gastro-enterostomy was done.

CASE III.—Blake:[11] Patient completely well two years after the closure of an indurated pyloric ulcer by suture plus posterior gastro-enterostomy. The patient had previously had "stomach trouble" of moderate severity extending over a considerable number of years.

CASES IV., V., and VI.—Steinthal:[100] In these cases, the fact is mentioned that the ultimate result was excellent without further detail.

CASES VII and VIII.—Paterson:[96] Patients well 15 and 24 months, respectively, after the closure of a perforation with gastro-enterostomy. No further detail given.

CASE IX.—Noetzel:[94] Two and one-half years after excision, suture, superposition of an omental flap, and a posterior gastro-enterostomy, patient's general health was excellent.

For the post-operative histories of the three following cases, I am greatly indebted to Dr. McWilliams. The cases were reported in the ANNALS OF SURGERY, Volume 8, 1911, page 140, and the following is a report of their condition one year later:

CASE X. Perforation near lesser curvature and pylorus with induration. Closed by Lembert and two tiers of sutures. This patient remained well until the past week (20 months after the operation). During the past week he has suffered from constipation and three or four attacks of vomiting several hours after eating. The stomach has been sour and the tongue slightly coated. The symptoms may be due to a hernia in the scar.

Digitized by Google

CASE XI. Twenty months ago patient J. S. was operated on by suture and posterior gastro-enterostomy for a pyloric perforation. One year after operation patient had an empyema of unknown cause. Two weeks ago patient had an attack of epigastric pain similar to that which the operation had relieved. At present he is completely well.

CASE XII. H., 28. Patient had had from childhood almost continuous knife-like pain with vomiting, most marked at night and on lying down. Three years before the operation for the perforation the appendix was removed in another hospital without relieving the symptoms. The diagnosis of gall-stones was then made. The attack of the perforation resembled other previous attacks that had been diagnosed as gall-stone colic. At this time operation (McWilliams) disclosed a perforation in the centre of an indurated ulcer the size of an egg just to the cardiac side of the pylorus. It was closed by Lembert sutures in tiers together with a posterior gastro-enterostomy by suture.

Post-operative: For six months after the operation patient was relieved but not cured, the pain and vomiting continuing although with diminished severity. About six months after the closure of the perforation, the patient was operated on for epigastric hernia. Inspection of the stomach showed no sign of the old ulcer and a patent pylorus. Since this operation for hernia the pain has been worse than prior to the operation for perforation, and the vomiting has been just as frequent and persistent. Although patient vomits once or twice daily three or four hours after eating, there has been no loss of weight. Tongue slightly coated but clear at the tip. Occasional sour taste in the mouth. Stomach analyses by Dr. H. S. Carter show at present a marked hyperacidity.

Through the courtesy of my colleague, Dr. Blake, the history of the following case is added:

CASE XIII. J. S., male, 31. Admitted to the Presbyterian Hospital December, 1909. Patient has complained of moderate stomach trouble for years. This has consisted chiefly of epigastric pain, occurring several hours after eating and relieved by the further taking of food.

The present attack of severe epigastric pain is of three hours' duration. Immediate operation. After examination of the appendix through an intermuscular incision, the pylorus was exposed and a perforation in the center of an indurated pyloric ulcer was found. This was closed by Lembert suture and a posterior gastro-enterostomy was added. The abdomen was closed without drainage. There was no vomiting nor indigestion during convalescence.

It is now two years since the operation, and the patient has had no stomach trouble of any kind whatever.

Digitized by Google

Of the character of the end results after suture only, the evidence is of greater value in that not only are the cases more numerous but the period of observation has extended over a longer time. An analysis of these cases appears to show that in a very considerable proportion the patient is either much improved or permanently cured. The writer, in his previous paper,[80] reported 53 instances collected from the literature and from his own experience, in which for periods of from one to six years the patients had been completely free from all gastric symptoms, and to this number should now be added a summary of the end results reported by Dahlgren,[24] Morton,[90] and Petrén,[102] and others.

Dahlgren[24] reports well 7 years after the operation, 2 cases; 5 years after, 1 case; 4 years after, 1 case; 2 years after, 3 cases; 3 months after, 1 case; 2 cases, in which symptoms persist.

Morton[90] reports well 3 years after the operation, 3 cases; 2 years after, 2 cases; 1 year after, 1 case; 1 case, in which symptoms persist.

Petrén[102] reports well 6 years after the operation, 1 case; 5 years after, 2 cases; 4 years after, 1 case; 3 years after, 2 cases; 2 years after and 1 year after, of each 3 cases; less than a year, 2 cases. Of 28 cases, 15 were without symptoms; 8 had slight or occasional symptoms, and 5 had severe symptoms. This author calls attention to the fact that cases in which the perforation has occurred without warning are more likely to be permanently relieved than those in whom there has been a persistent gastric history for some years. It is also worthy of mention that, in his experience, perforations of ulcers at or near the lesser curvature are more likely to be followed by persistent symptoms than those at or near the pylorus.

Jopson[58] reports one patient who, three years after the closure of a perforation by suture, was perfectly well with the exception of occasional attacks of fermentation.

Hessert[121] reports a patient well 18 months after the simple closure of a perforation.

McWilliams[73] reports a patient well four and one-half years after the simple suture of a perforation. Two years after the operation he had one attack of indigestion.

Through the kindness of Dr. Peck, his valuable end results in cases previously reported by him and cited by the writer in his former paper[99] are herewith appended:

Digitized by Google

CASE I (25 in former paper). Not traced further.

CASE II (26 in former paper). Well four years after operation. Then lost sight of.

CASE III (27 in former paper). Well four years after operation.

CASE V (28 in former paper). Patient has occasional gastric distress after indulgence in alcohol. Otherwise well four years after operation.

CASE VII (29 in former paper). Patient had an ulcer in the middle of the anterior wall. Occasional pain and indigestion persisted. In January, 1911, four years after the closure of the perforation, Dr. Peck exposed the stomach which had become an hour-glass one, and relieved the patient by doing a gastro-enterostomy. The patient has been perfectly well since.

CASE VIII. In 1907 suture of duodenal perforation. One year later a second perforation occurred at the same point. This was also sutured. Fourteen days later a gastro-enterostomy was done for symptoms of pyloric stenosis. Death occurred several days later, and an autopsy showed a beginning carcinoma in the old duodenal ulcer.

A résumé of the final results operated on by the writer follows:

CASE I (reported in previous paper). Perforation on the anterior wall of the stomach midway between the cardia and pylorus. Suture only. Patient well at the end of four years when she passed out of view.

CASE II (reported in previous paper). Pyloric ulcer closed by suture. Patient completely well eight years after operation.

CASE III (reported in previous paper. See also secondary, gastro-enterostomy after primary suture of perforation). Patient well for three and one-half years after operation for perforation on anterior surface of first part of duodenum. Then symptoms of ulcer recurred, and two years later gastro-enterostomy was done in Germany. Patient has been completely well since this last operation.

CASE IV (reported in previous paper). Perforation on anterior wall of first part of duodenum. Patient entirely well for two and one-half years, when ulcer symptoms recurred, and he suffered from two attacks of pain. Efforts to trace him latterly have failed.

CASE V (reported in previous paper). Perforation on the anterior wall of the stomach two inches from the pylorus near the lesser curvature. Suture. This patient made an excellent recovery but was soon lost sight of.

CASE VI (reported in previous paper). Perforation at junction of pylorus and duodenum closed by suture. Recovery. Patient cannot be traced.

CASE VII (reported in previous paper). Perforation on the anterior surface of the first part of the duodenum closed by suture. Patient completely well five years after the operation.

CASE VIII (reported in previous paper). Perforation on the anterior surface of the first part of the duodenum closed by suture. Patient had

Digitized by Google

advanced atheroma at the time of operation, and one year after died from intercurrent disease.

CASE IX (reported in previous paper). Perforation on the anterior wall of the second part of the duodenum closed by suture four days after the onset. Patient died four days after the operation.

CASE X (not previously reported). Male, aged fifty-two. Admitted to the Presbyterian Hospital, January 26, 1910.

Patient has always been well. There was a history of the excessive use of tobacco and the moderate use of alcohol. On January 16, there was epigastric discomfort especially on the right side, which soon became associated with eating but did not interfere with the patient's work (laborer). The pain was localized, of knife-like character. It lasted for about 20 to 30 minutes after eating, and was bad enough to make the patient diminish the amount of food he ate. Early on the morning of admission, as patient was leaving work (night laborer), the pain became very severe. He walked with difficulty to the trolley, and on reaching home he walked up several flights of stairs. The pain was so severe that he was brought to the hospital in an ambulance.

Physical Examination.—The tongue was markedly coated. There had been neither nausea nor vomiting at any time since the onset. The epigastric region was retracted, and the entire abdomen moved very slightly with respiration. There was general board-like rigidity, most marked in the upper right quadrant. The upper segment of the right costal arch was also rigid, and pressure on this point as well as in the epigastric region to the right of the median line was painful. There was dullness in the right flank as far forward as the edge of the rectus muscle. The pulse was only 48 and strong. There was no rise of temperature, and respiration was only slightly quickened. There was a general leucocytosis of 13,000 and a polymorphonuclear count of 93 per cent. Three days later these had diminished to 5,000 and 60 per cent. respectively.

Immediate operation eight hours after the perforation. Under gas and ether anæsthesia, the abdomen was opened through an upper right pararectal incision. A small amount of gas escaped, and a considerable yellow exudate which filled the right loin and the right lumbar gutter as far as the appendix. It did not extend into the pelvis. After removal of the exudate, examination showed an induration in the end of the first part of the duodenum, anterior surface, with a small punched-out hole in its centre. This was closed with a purse-string suture reinforced by two Lembert sutures, and after irrigation of the right lumbar gutter and the corresponding subphrenic space, into which a cigarette drain was introduced, the abdominal incision was closed in the usual way.

The recovery was without incident. At no time was the pulse over 80. Cultures taken from the exudate near the perforation showed no growth.

Digitized by Google

Present Condition.—Two years after the operation, the patient is free from all gastric symptoms.

CASE XI (not previously reported). Male, S. J., aged thirty. Admitted to the Presbyterian Hospital June 20, 1910.

There was a history of the excessive use of tobacco, coffee, and tea. Moderate use of beer. No previous gastric history. On afternoon of admission, while working, patient was seized with a violent pain in the right hypogastrium. Patient vomited once after a glass of brandy taken in order to relieve the pain. Brought to the hospital in the ambulance.

Physical Examination.—The respiratory movement of the abdominal wall was restricted. There was general rigidity, especially in the right upper quadrant. The rigidity was least marked in the flanks. There was bilateral costal resistance, especially in the upper right segment. The left side of the abdomen was tympanitic. The right side on auscultatory percussion showed an area of dullness extending from the margin of the rectus into the loin. The tympany in the right flank was higher pitched than on the left side. There was marked tenderness on pressure opposite the navel.

Chloroform followed by ether, four hours after the perforation. Right upper pararectal incision. There was free yellow fluid without gas in the right upper quadrant, not sufficiently abundant to have extended down the right lumbar gutter or into the pelvis, but limited to that part of the peritoneal cavity above the level of the transverse colon. There was a perforation the size of a buckshot in the upper anterior portion of the first part of the duodenum without discoverable induration. This was closed with a purse-string suture reinforced by two Lemberts, and the abdomen closed after local irrigation of the upper right portion of the peritoneal cavity. A small cigarette drain was introduced into the right subphrenic space and the abdomen closed in the usual manner.

The patient made an excellent recovery but could not be traced three months after leaving the hospital.

CASE XII (not previously reported). Male, aged forty-four. Admitted to the Presbyterian Hospital March, 1911.

There was a history of the moderate use of alcohol and tobacco. For the past year patient has been subject to mild attacks of pain occurring from two to four hours after eating, which were relieved by further eating and by bending forward. One year ago during an attack of one week's duration there were several attacks of vomiting. During the entire year, however, he has complained of indigestion with vague sensations of pain and oppression in the epigastrium, sometimes radiating to both shoulder-blades. He has also suffered from gaseous eructations and occasionally vomited a greenish fluid.

On the day prior to his admission he had a sudden attack of pain, severe and colicky, in the epigastric region; this radiated to the left and was persistent. There was no history of vomiting. The bowels had not moved for 48 hours and two enemas had been given without result. Upon admission

Digitized by Google

the abdomen was found moderately distended; it was very rigid, especially in the right upper quadrant, with generalized tenderness and tympany except in the right flank, where dulness as far forward as the edge of the rectus was elicited. A rectal examination was negative, revealing no tenderness. The patient's temperature was 99.5°; pulse, 116; respirations, 24. A blood count showed 7000 white blood-cells with 87 per cent. polymorphonuclears. The urine contained a heavy trace of albumin and casts. The patient was seen in consultation by Dr. Horold of Macon, Ga., who made the correct diagnosis.

Operation 36 hours after perforation. Under ether anæsthesia, the abdomen was opened through a right upper pararectal incision. This incision was subsequently enlarged by a transverse incision extending from its upper part toward the median line. There was an immediate gush of a large quantity of turbid, dark-colored fluid, containing gastric and duodenal contents, which completely filled both subdiaphragmatic spaces as well as the space between the left lobe of the liver and the anterior abdominal wall. The right lower half of the abdomen and the pelvis were also filled with fluid of the same character. The fluid was thicker, more grumous, and more offensive about the pyloroduodenal junction than at more distant points. A perforation in an indurated ulcer of the size of a 25-cent piece was found in the anterior upper wall of the duodenum just beyond the pylorus. It was closed by a purse-string suture reinforced by two Lembert sutures. The peritoneal cavity was cleansed by general irrigation, and cigarette drains were introduced into either subdiaphragmatic space above and through a counteropening above the symphysis into the pelvis below. The abdominal incision was then rapidly closed in the usual manner.

Post-operative.—The patient made an excellent recovery from the anæsthetic. On the day after the operation his pulse was less than 100 and there was no nausea or vomiting. Fluids by mouth were given from the fifteenth hour. For a week the drainage was satisfactory. The discharge from the suprapubic opening was serous, and after the drain was removed on the fifth day the sinus rapidly closed. The discharge from the upper opening was offensive and purulent, and some of the sutures giving way the wound healed slowly by granulation. At the end of ten days the temperature chart and blood counts indicated pus retention, and as the patient's condition did not warrant posterior drainage through the pleura, the device of attaching siphon drainage to a catheter introduced into either subdiaphragmatic space was adopted with excellent results. The sinuses ultimately closed, the one between the left lobe of the liver and the anterior abdominal wall, which was the least deep, was the last to heal. Three months after the closure of the perforation a stomach analysis showed no hyperacidity. Nine months after the operation a second gastric analysis showed a moderate hyperacidity. In all other respects, however, the patient is perfectly well.

Digitized by Google

CASE XIII (not previously reported). Female, aged twenty. Referred to me by Dr. H. R. Charlton of Bronxille, to whom I am greatly indebted for the subsequent post-operative history.

For the past two years she had been treated by various medical men for an "acid stomach," receiving a large amount of alkalies for its relief. Eighteen months ago pain was added to her difficulties, especially severe after taking food. There was no vomiting and only slight constipation. One month before operation patient developed tenderness in the epigastric region, which increased to such an extent that the pressure of the clothing could be tolerated for short periods only. Shortly after consulting Dr. Charlton for the first time, patient took a half ounce of castor-oil and five hours later while sewing she had a sudden severe knife-like pain in the epigastrium with a feeling of faintness and vomiting. On examination there was restricted abdominal respiration, general rigidity most marked above the level of the navel and slightly to the right of the median line, moderate tenderness, no temperature, and a pulse of 100.

Operation at the Lawrence Hospital in Bronxville 18 hours after perforation. The rigidity being most intense just prior to the operation over the region of the appendix, an intermuscular incision was first made and the appendix was inspected. On opening the abdomen there escaped the characteristic fluid so frequently seen in connection with pyloric perforations, which abundantly filled the entire pelvis and the right lumbar gutter. The pylorus was then exposed by the usual upper right pararectal incision, and a perforation the size of a millet-seed found close to the junction on its anterior surface. This was rapidly closed with a purse-string suture, strengthened with two Lemberts, and the right subphrenic space and pelvis carefully cleansed by saline irrigation. The abdomen was then closed, cigarette drains being first introduced into the right subphrenic space and pelvis through the intermuscular incision.

The patient recovered well from the anæsthetic and for the first week did very well. There was practically no vomiting, and the patient took her nourishment without difficulty. After that time patient developed a left pleurisy with effusion, a patch of pulmonary gangrene, a left-sided pelvic abscess, and multiple abscesses in the subcutaneous tissue. These different post-operative complications were all successfully weathered, however, and now, six months after the operation, Dr. Charlton tells me that the patient is eating well and gaining weight rapidly, and is able to attend to the customary household duties.

CASE XIV. G. R., admitted to the Presbyterian Hospital March, 1910.

Three years ago patient had dull epigastric pain which was cured by lavage. In March and May, 1909, patient had similar attacks, which were relieved in the same way. In August patient was operated on at the New York Hospital for acute perforation of the pyloric-duodenal junction by Dr. Bolton. The perforation was closed by a purse-string suture reinforced by

Digitized by Google

Lemberts and the superstition of an omental flap. The patient remained entirely well until two weeks ago (seven months after the operation), when the gastric symptoms recurred and vomiting, which was persistent, developed.

On physical examination the greater curvature of the stomach reached to the umbilicus and test-meals showed both gastric stasis and a lack of digestion. Further analysis showed a total acidity of 0.3 per cent., with hydrochloric acid 0.27 per cent., and no lactic acid.

Chloroform. The abdomen was opened through a median incision above the navel. The stomach was moderately enlarged. To the vicinity of the pylorus the omentum was attached, and had formed dense adhesions which were not disturbed. Through these adhesions the first part of the duodenum felt as if considerably thickened with cicatricial tissue. A typical posterior gastro-enterostomy was done, which completely relieved the patient. Twenty months after the operation the patient had no relapse.

In conclusion, the writer wishes to emphasize the importance of publishing complete reports of both the primary and final results of all cases of perforation, irrespective of the form of treatment. It is only by a study of such frank and accurate records that the real value of the different methods of treatment of this very important lesion can be determined.

The writer also takes the opportunity to thank most sincerely Professors Körte, Kregius, Noetzel, Brentano, von Eiselsberg, Shoemaker, Martens, and Drs. Petrén and Kreiss, together with Mr. Moynihan of Leeds, and Drs. Mayo, Peck, and McWilliams, for their kind and valuable assistance in the preparation of this paper.

BIBLIOGRAPHY.

[1] Ackermann: These de Lausanne, 1896.
[2] Andrew: Lancet, Lond., Oct. 30, 1909, II, p. 1273.
[3] Allaben: Ills. Med. Jour., Springfield, 1910, XVIII, 290.
[4] Allaben: Ills. Med. Jour., Springfield, 1909, XVI, 146.
[5] Axhausen: Zeit. f. Chir., 1910, XVII, 193.
[6] Bamberger: Die Innen und d. Chir Behand. des Chir. Magengeschwürs, etc., Berlin, 1909.
[7] Battle: Brit. Med. Jour., 1910, I, 989.
[8] Beck: Wein. med. Woch., 1910, LX, 1884.
[9] Bevan: Lancet, Lond., 1911, I, 1419.
[9a] Bessel-Hagen: Deutsch. med. Woch., 1907, XXXIII, 1657.
[10] Bidwell: Brit. Med. Jour., 1909, I, 1280.

Digitized by Google

[11] Blake: Rev. de Chir., 1908, 11.
[12] Borszeky: Beitrag. z. klin. Chir., 1908, LVII, 56.
[13] Braun: Centralblatt. f. Chir., 1897.
[14] Brentano: Archiv. f. klin. Chir., 1906, 81, 125.
[15] Brewer: Annals of Surgery, 1908.
[16] Brunner: Deutsch. Woch. f. Chir., 1903, 69.
[17] Busch: Archiv. f. klin. Chir., 1909, XC, 1.
[18] Caird: Trans. Med. Surg. Soc., Edinburgh, 1906, ns. 25, 274.
[19] Clairmont: Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1909, XX, 330.
[20] Carwardine: Lancet, Lond., 1910, I, 239.
[21] Clement: Rev. med. d. l. Suisse, Geneva, 1909, XXIX, 318.
[22] Cobb: Boston Med. and Surg. Jour., 1909, CLX, 204.
[23] Collinson: Proc. Roy. Soc. Med., London, 1909-1910, Surg. Sect., 79.
[24] Dahlgren: Nord. Med. Arkiv., 1908, XLI, Ht. 3, Nos. 11, 12.
[25] Dandelski: Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1911, 533.
[26] Daurine: Annal. Soc. de Med. d'Anvers, 1909, LXXI, 41.
[27] Deaver: Annals of Surgery, 1908, XLVII, 894.
[28] Denechau: These, Paris, 1906-7.
[29] Downes: Annals of Surgery, 1910, II, 123.
[30] Eliot: American Jour. Surg., Oct., Nov., Dec., 1908; Jan., 1909.
[31] Falkenburg: Cit. by Kroiss.
[32] Federmann: Deutsche Zeit. f. Chir., 1907, 87.
[33] Feirsterer: Beitrag z. klin. Chir., 1910, 68, 532.
[34] Fenwick: Brit. Med. Jour., 1910, I, 443.
[35] French: Guy's Hospital Rep., 1907, vol. LXI.
[36] Gaudemet: These, Paris, 1905-6.
[37] Gilli: Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1907-8, XVIII, 103.
[38] Gosset: Revue de Chir., 1906, XXXIII, 54, 290.
[39] Graf: Deutsche Zeit. f. Chir., 1907, XC, 365.
[40] Haim: Zeitschr. f. Heilkunde, 1905, 26, 88.
[41] Hamann: Lancet, Lond., 1907, I, 1587.
[42] Hartwell: Annals of Surgery, 1908.
[43] Harrison: Brit. Med. Jour., 1910, I, 140.
[44] Harslöf: Disput., Copenhagen, 1907.
[45] Heussler: Verhandl. d. deutsch. Gesselschaft f. Chir., 1895, 39.
[46] Heinemann: Deutsche med. Woch., 1910, XXXVI, 1186.
[47] Hofmeister: Beitrag. z. klin. Chir., 59, 625.
[48] Hofmann: Beitrag. z. klin. Chir., 1906, L, 710.
[49] Howitt: Medical Record, 1900, II, 551.
[50] Hubbard: Boston Med. and Surg. Jour., 1909, CLX, 588.
[51] Ito and Sayesima: Deutsche Zeit. f. Chir., 1908, XCV, 597.
[52] Jaffe: Berlin. klin. Woch., 1908.
[53] Jopson: Annals of Surgery, 1909, XLIX, 724; 1911, LIV, 2.
[54] Körte: Archiv. f. klin. Chir., 1906, LXXXI, 83.
[55] Körte: Verhandl. d. Hufeland. Gesellsch im Berlin, 1907, 16.

Digitized by Google

[60] Körte: Berlin. klin. Woch., 1907, XLIV, 226.
[61] Kramer: Beitrag. z. klin. Chir., 1906, LI, 289.
[62] Kreutzer: Beitrag. z. klin. Chir., 1906, XLIX, 380.
[63] Krogius: Archiv. f. klin. Chir., 1905, LXXV.
[64] Keen and Musser: Jour. A. M. A., 1894, II.
[65] Krönlein: Archiv. f. klin. Chir., 1906, LXXIX, 644.
[66] Kroiss: Beitrag. z. klin. Chir., 1910, LXVII, 509.
[67] Kütner: Berlin klin. Woch., 1911, 48, 273.
[68] Kütner: Ther. a. gegenw. Berl., 1911, LII, 19.
[69] Kütner: Arch. f. klin. Chir., 1910, 93, 410.
[70] Lecene: Jour. de Chir., 1911, 369.
[71] Leriche: Ibid., 1911, 453.
[72] Lambotte: Cong. d'l Soc. Internat. de Chir., Brusselles, 1906, 294.
[73] Lockwood: Jour. A. M. A., 1911, LVI, 948.
[74] Lieblein: Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1910, XXI, 842.
[75] Lennander: Hygiea, Bd., LXIX.
[76] Leroy and Minet and Durrgey: Gaz. Heb. d. Sc. Med., Bordeaux, 1904, 573.
[77] McWilliams: Annals of Surgery, 1911, 53, 140-144.
[78] Marnoch: Brit. Med. Jour., 1909.
[79] Martens: Berl. klin. Woch., 1910.
[80] Martens: Deutsche klin. Woch., 1910; see Petre, XLVII, 421.
[81] Mayer: Beitrag. z. klin. Chir., 1908-9, LXI, 150.
[82] Mayo, W. J.: Annals of Surgery, 1908, XLVII, 885.
[83] Monnier: Korr. f. Schw. Aertze, 1908.
[84] Miles: Edinburgh Med. Jour., 1906, 106.
[85] Milko: Cent. f. Chir., 1906, 106.
[86] Mitchell: Brit. Med. Jour., 1909, II, 946.
[87] Monprofit: Arch. prod. de Chir., 1907, XVI, 288 and 317.
[88] Moreau: These, Paris, 1908-9.
[89] Moynihan: Lancet, Lond., 1905; Surg., Gyn., and Obst., 1907, IV, 677; Annals of Surgery, 1908, XLVII, 873.
[90] Mühsam: Deutsche med. Woch., 1910, 23.
[91] Murphy: Surg., Gyn., and Obst., 1908, VI, 591.
[92] Maylard: Lancet, Lond., 1910, I, 443.
[93] Martin: Annals of Surgery, 1909, XLIX, 863.
[94] Morton: Med. Press and Circ., 1909, CXXXVIII, 81.
[95] Mitchell: B. M. J., 1909, II, 946.
[96] Neumann: Zeitsch. f. Chir., C, 298.
[97] Noall: Brit. Med. Jour., 1909, I, 1287.
[98] Noetzel: Beitrag. z. klin. Chir., 1906, LI, 247 and 497.
[99] Nordmann:
[100] Nyrop: Deutsche Zeit. f. Chir., 1907, XXXVII, 330.
[101] Paterson: Proc. Roy. Soc. Med., 1908-9, II, 238; Lancet, Lond., 1906, 575.

Digitized by Google

[96] Paterson: Annals of Surgery, 1909, L, 367.
[99] Peck: Med. Record, 1907, LXXII, 930.
[100] Percy: Surg., Gyn., and Obst., 1910, X, 316.
[101] Pernitza: Wein, med. Woch., 1907.
[102] Petrén: Beitrag. z. klin. Chir., 1911, II, LXXII, 319.
[103] Rubritius: Beitrag. z. klin. Chir., 1910, LXVII, 222.
[104] Schmitt: Beitrag, z. klin. Chir., 1910, LXX, 269.
[105] Shoemaker: Mitt. a. d. Grezgeb. d. Med. u. Chir., 1909, XX, 21.
[106] Schulz: Deutsche Zeit. f. Chir., 1907, LXXXVIII, 494.
[107] Sonnenburg: Mitt. a. d. Grenzgeb d. Med. u. Chir., 1911, 553.
[108] Steinthal: Beitrag. z. klin. Chir., 1909, LXV, 358.
[109] Souligoux: Bull. et mem. Soc. de Chir., 1909, XXXV, 339.
[110] Stirling: Centralblatt f. Chir., 1908.
[111] Steimpf: Beitrag. z. klin. Chir., 1908, LIX, 551.
[112] Taylor: Arch. Middlesex Hosp., Lond., 1909, XIV, 49.
[113] Vautrin: Arch. gen. d. Chir., 1910, IV, No. 12.
[114] Villard and Pinnatello: Revue de Chir., 1904, I, 24.
[115] Von Eiselsberg: Deutsche med. Woch., 1906, XXXII, 2017.
[116] Von Khautz: Arch. f. Klin. Chir., Bd., 85.
[117] Wallis: Lancet, Lond., 1898, II, 1477.
[118] Ward: Lancet, Lond., 1907, 19.
[119] White: Lancet, Lond., 1910, 1910, I, 268.
[120] Wickerhauser: Cit. by Kroiss.
[121] Wilkie: Arch. gen. de Chir., 1910, IV, No. 12.
[122] Witherspoon: South. Med. Jour., 1910, III, 56.
[123] Woolsey: Annals of Surgery, 1909, XLIX, 858.
[124] Albrecht: Beitrag. z. klin. Chir., LXXIII, II, 464.
[125] Cuff: Brit. Med. Jour., 1907.
[126] Dege: Deutsche med. Woch., 1909, 1266.
[127] Miller: Annals of Surgery, 1911, LIV, II.
[128] Ross: B. M. J., 1911, I, 137.
[129] Wharton: Annals of Surgery, 1911.
[130] Lundblad: Hygiea, 1907.
[131] Hessert: Surg., Gyn., and Obst., 1907, IV.

Digitized by Google

XVIII.

POST-OPERATIVE INTESTINAL OBSTRUCTION.*

By George Woolsey, M.D., Associate Visiting Surgeon.

Whether it occurs as a complication of convalescence or months or years after the abdominal section, there is no other condition that more imperatively demands early diagnosis and prompt relief. In the one instance it may occur when the anxiety of both the surgeon and patient alike has begun to relax with the establishment of convalescence; in the other, it often comes like a thunderbolt out of a clear sky when the operation and its cause are things of the past, and there is no thought of a lurking danger in the few remaining adhesions. In spite of the improvements in technique in intraperitoneal operations, this complication occurs not uncommonly, for, by very reason of the improved technique, the number of such operations has been vastly increased. In the case of septic or paralytic obstruction, however, modern technique has greatly reduced its relative frequency.

In the past five years there have been 50 cases, recorded as post-operative and post-inflammatory intestinal obstruction, treated at the Presbyterian Hospital, 60 per cent. of which were complete and 40 per cent. partial obstructions. Of these, only 6 have been instances of paralytic obstruction, while adhesions were noted in 19, bands in 12, and both bands and adhesions in 10, causing strangulation in 9 cases, volvulus in 2, and angula-

*Read before the American Surgical Association, Washington, May 2, 1910.

(*Reprinted from Surgery, Gynecology and Obstetrics, June,* 1910.)

Digitized by Google

tion or a valvular closure (ventilverschluss) in most of the other cases. Nine of these have been in my service (8 operations, mortality 12.5 per cent.) and I have had an equal number during that time in private practice and in my service at Bellevue Hospital. The statement has been made by a writer (1) on this subject, six years ago, that the majority of cases occur within two weeks of the operation. This has not been my experience, and of the 50 cases above mentioned, 70 per cent. occurred after the two weeks' period. Perhaps the improved technique in the operation and after treatment of cases of septic peritonitis has so diminished the number of cases of paralytic obstruction as to account for this great difference in percentage.

There are so many interesting questions involved in the etiology, diagnosis, prevention, and treatment that the subject is an absorbing one. It is one also that concerns all surgeons. As to classification we have already intimated that cases may occur early or late, according to Broca's division. The late cases are all of mechanical origin; the early cases may be mechanical or paralytic.

The cases of mechanical post-operative obstruction may be due to *strangulation,* when the circulation is interfered with from the pressure of a band or from a volvulus, or both, or to an *obturation,* due most often to an angulation by the kinking of the gut and the formation of a valve-like arrangement, preventing the contents of the distended proximal segment of the loop passing into its distal segment. In time in a mechanical obstruction the gut may become paralyzed, by reason of overdistension, so that the two forms may be associated in one case.

Paralytic obstruction is most often, but not invariably, due to sepsis. There are a few interesting cases of paralytic obstruction, which depend upon disturbances of the innervation

Digitized by Google

or circulation of the bowel, the so-called adynamic obstruction. In a few cases also the temporary paralysis due to handling of the intestine seems to have been unduly prolonged so as to cause obstruction. The above classification is a convenient one in studying these cases.

ETIOLOGY. The two great etiological factors in post-operative obstruction are either of a septic or a mechanical nature. The etiology of mechanical obstruction is not difficult to understand, though the mechanism is varied. When due to strangulation, the cause is usually a band or a volvulus, or both. I have recently operated on an example of the latter type where a band, due to an operation thirteen years before, had so narrowed the mesentery at the base of a loop of ilium, as to render volvulus an easy matter. In addition, the band, itself, tightened by the twist of the volvulus, strangulated the mesentery and compressed one end of the loop. Resection of fourteen inches was done and recovery was uneventful. In strangulation there is usually an obturation, at one or both ends of the loop, from the band or volvulus, but the important factor is the stasis of the blood supply. Thrombosis occurs in time, and may subsequently extend. Whether the nerves that accompany the vessels are paralyzed by pressure or not is of little moment, for the mesenterie or Auerbach's plexus is capable of carrying on peristalsis independently. When, however, the blood supply is entirely cut off from this plexus, paralysis of the gut soon follows in the same way as it does in cases of thrombosis of the mesenteric vessels. Hence, in strangulation we eventually have a combination of mechanical and paralytic obstruction. The importance of early diagnosis and relief is evident in order to prevent or anticipate the occurrence of paralysis and gangrene of the loop of gut. Fortunately, the onset of strangulation is often

Digitized by Google

gradual and not complete at once, so that by early operation we are able to relieve the condition without intestinal resection. The band causing the strangulation I have found due to an adherent omentum, an adherent loop of intestine, or, more commonly, an old adhesion.

OBTURATION. A band of adhesions may also cause a simple obturation, without strangulation, if it compresses the bowel transversely to its long axis, and thus does not cut off its circulation.

The commonest form of mechanical obstruction depends upon a kinking or angulation of a loop of gut due to its adhesion to the parietes or another loop. This I have found most often in or just above the pelvis and the small intestine is the part involved, as it is also in the vast majority of all cases of post-operative obstruction (95 per cent, Gibson). Intestinal adhesions are exceedingly common for they follow almost all abdominal operations and most peritoneal inflammations to a greater or less extent. In the past sixteen months I have operated on two cases of obstruction, due to adhesions, with a history of an inflammation some time before, but no operation, and three others of the 50 cases collected at the Presbyterian Hospital during the last five years were of this nature. We know that most of the peritoneal adhesions formed become stretched, attenuated, and disappear, largely under the influence of repeated peristalsis. Some that are firmer than others and those existing where the source of infection is still present, may remain, or, if in the latter category, may increase. But we know from our experience in operating on many cases presenting peritoneal adhesions, that by far the greater number of these do not give rise to obstruction. Post-operative obstruction often follows the cases in which we little expect it and not

Digitized by Google

the worst cases. In acute suppurative appendicitis, and in peritonitis from other causes, many intestinal loops adhere, and are held together in a normal and not in an abnormal position, as after some operations where the intestines are much handled. Otherwise, obstruction would be more common after unoperated appendicitis than it is.

The factor that seems to determine the obstruction is the adhesion of a loop of gut in an abnormal position. Hence, also the disadvantage of opening an acute appendicitis requiring drainage to the inner side of the cæcum where the drainage tract may result in adhesions of the small intestine to the cæcum. Hawkes[2] has found such adhesions to be the cause of the obstruction in several cases. In operating for obstruction I have often found a loop of small intestine angulated by adhesions to the bottom of the pelvis, where it did not normally belong. The method of floating the intestines into place by pouring in hot normal saline solution at the end of the operation, is therefore a rational one.

Another factor to be considered in the matter of adhesions is a personal idiosyncrasy to the formation of firm adhesions, and often of many such. In most cases of mechanical obstruction a few firm adhesions, or only a single one, are found, and the greater part of the peritoneal cavity is free from them. I have observed this idiosyncrasy to adhesion formation in three or four cases, and it has been referred to by others. Thus, Lillienthal thinks that such idiosyncrasy is more common among women. About three and a half years ago I operated on a young woman of nineteen (No. 3385 Presbyterian Hospital) for partial obstruction. This was the fifth operation for obstruction since an operation for appendicitis two years before. Here, in spite of the removal of the appendix there were many adhesions causing the angulation of two or three loops

Digitized by Google

of small intestine without producing complete obstruction. The attempt was made by the use of the Cargile membrane and omental grafts to prevent the adhesions reforming, but I heard of her a few months later as being again in a similar condition, and suggested the use of thiosinamin or fibrolysin. I have also seen two young men who had been operated several times for obstruction after appendectomy. They both presented symptoms of obstruction, with very great distension, but refused further operation. One was partly relieved by repeated enemata. Brewer has also reported a case in which there had been eleven laparotomies, six of which were for obstruction.

The usual mechanism of the obstruction occasioned by kinking or angulation, whether due to adhesions or to great distension, is after the manner of a trap (ventilverschluss). Thus, the gas or fluid contents in the proximal or oral arm of the loop presses the distended outer end of this arm against that of the distal arm and closes it, as the ureter is closed in a case of high implantation in the pelvis, by the pressure of the fluid in the latter. The adhesion draws out the two arms of the loop so that they are parallel and in contact, so that distension in one tends to close the other, and it prevents the bend of the loop from being straightened out by the peristaltic action. Fischer[3] reports three autopsies for post-operative obstruction, in which the bowel was included in the deep tension sutures of wire, by the peristaltic action, and occluded. These were operated by three well-known surgeons, and he has known of other cases where the bowel was impaled by the suture. Fortunately, such cases are not common.

In many early cases, due to angulation from adhesions, the obstruction is probably not complete until an attack of indigestion or an indiscretion in diet causes an increase in the amount of gas in the proximal arm of an adherent loop.

Digitized by Google

Another cause of early post-operative obstruction, in cases with an extensive peritonitis, is secondary abscess. These are not infrequently reported, and almost without exception the obstruction is attributed to the adhesions of the intestinal coils forming the walls of the abscess or possibly to a local septic paralysis. I have operated on several of these within the past few years, and without exception the obstruction has been relieved at once by the evacuation of the pus. My own explanation after studying these cases, is that the obstruction is due to the pressure of the abscess. The adhesions are a contributing cause, for they prevent the loops of gut from escaping from the pressure of the abscess which occludes the gut in a valve-like way (ventilverschluss), the abscess taking the place of the collection of gas or intestinal contents in the ordinary mechanical obstruction from adhesions. Or again, an adherent loop may be compressed between the abscess and some firm structure, like the abdominal wall.

Another etiological factor sometimes reported as a cause of post-operative obstruction is the Trendelenburg position. In two or three cases that I have observed this has seemed to be the cause or a contributing cause of obstruction. Kraske has reported two cases following suprapubic operations, but most have followed laparotomies. It has seemed to me that the intestines, by reason of an abnormal position in which they are left or by the pressure of the rolled-up omentum, cannot readily expel the gas, and become more and more distended until the distension, by kinking them and rendering them paretic, continues and increases the trouble. Hence, the importance of letting the patient down and replacing the intestines and omentum in good position (as by floating them into position) before the wound is sutured.

Digitized by Google

In paralytic obstruction, the etiology is not always the same. A nearly similar result may be brought about by a septic peritonitis, handling of the intestines during operation, and direct or indirect disturbance of its nerve supply in extra-peritoneal operations, or injuries. Of course, septic peritonitis is the most common factor, but exactly why or how it causes the paralysis is not definitely known. It may be due to reflex action, vaso-motor disturbances or the direct effect of the toxins on the intestinal nerves or musculature. In the last analysis it must be through some action on the intestinal plexus or muscle fibres. We know that peristalsis is a co-ordinated movement, having its local reflex center in Auerbach's plexus, and that it can go on for a considerable time while the plexus is entirely disconnected from the central nervous system.

Cannon and Murphy have demonstrated that peristalsis may be reflexly inhibited through the splanchnic nerves. In a case of Kocher's the obstruction was due to reflex intestinal paralysis, due to strangulation of the omentum. I have observed a similar condition in a case of torsion of the omentum. A remote inflammatory focus, as in the pleura, may have a similar result, and I have known of it in pneumonia. In all these cases the intestinal paralysis is of reflex origin, and this is probably a common cause.

Another explanation accounts for the production of some cases. The handling of the intestine at the operation is followed by its paralysis for a few hours,—up to twenty-four or more. If it is unusually prolonged the paralyzed gut may become overdistended by the gases developed from the intestinal contents. Many, if not most of the mild cases of post-operative intestinal paralysis, are due to such a mechanical injury, while most of the severe cases depend upon sepsis.

Digitized by Google

Overdistension may lead to paralysis of the bowel as of the bladder and the paralysis is thus continued. Overdistension may also cause obstruction by kinking the intestine, and if the latter is so paretic that it cannot overcome the angulation, obstruction occurs from the same valve-like mechanism as when due to adhesions. Possibly paralytic obstruction may also be due to traction on the nerves of the mesentery in opposite directions by distended coils lying on opposite sides. Distension may also lead to volvulus. This same overdistension may occur with mechanical obstruction, and thus add a paralytic to a mechanical condition as a cause of the obstruction.

Israel[4] has reported two cases of isolated drum-like distension of the cæcum following an extraperitoneal kidney operation. Here, either the intestinal plexus was directly damaged or reflexly inhibited through the nerves connecting it with the abdominal ganglia. It is also well known that a blow on the abdomen may cause a paralysis of the peristalsis for some time, and the same cause has also resulted[5] in a ring-like stricture from an injury of the bowel wall.

It has been held that the overaction of the bowels, as seen in mechanical obstruction, results in their paralysis. This is denied by v. Stockum[6] who says that continued increased peristalsis does not lead to intestinal paralysis but to hypertrophy, a paresis never results. This is illustrated in the obstruction due to intestinal carcinoma.

The terms dynamic and adynamic obstruction are often used interchangeably and thus lead to confusion. Strictly adynamic obstruction is the paralytic form and dynamic is the rare form, due to a spasmodic contraction of a segment of gut, which has been shown experimentally to be of possible though rare occurrence. Little is known of it clinically, and we will not consider it further. In Mikulicz's very satisfactory classi-

Digitized by Google

fication into mechanical and dynamic obstruction, the latter includes all forms that are not of mechanical origin. To avoid confusion, it seems better to call the dynamic forms paralytic obstruction.

Sixteen years ago nearly all reported cases followed gynecological operations; to-day the majority follow operations on the appendix. This is natural, in view of the great numbers of such operations and the presence of the inflammation which of itself would give rise to adhesions. There can be no doubt that the extent and character of the adhesions, and the occurrence of early obstruction, are much influenced by the amount and character of the drainage, the technique of the operation itself, and the post-operative treatment. In only one of the 50 collected cases was the appendectomy an interval operation, five years before, though many such cases are reported. Pelvic operations form the second commonest cause, and of these, singularly enough, ovarian cysts are followed by obstruction relatively more often than pyosalpinx, in which the conditions would appear more favorable. In the 50 cases I collected at the Presbyterian Hospital, 32 followed appendicitis, of which 3 had not been operated, 13 pelvic conditions (5 ovarian cysts), 2 those of the stomach, and 1 a gall-bladder operation. In one case following an operation on the stomach a small segment of ileum was so twisted in its longitudinal axis as to cause obstruction. The patient had taken the anæsthetic badly and loops of small intestine had to be replaced within the abdomen, at the lower end of the incision, repeatedly during the operation. Such a mechanism of obstruction must be most uncommon.

Among those 50 cases, 33 were females and 17 males. The age varied from six months to seventy-three years, averaging 27.4 years. The average age of cases of complete obstruction

Digitized by Google

(22.3 years) was very noticeably lower than that of the cases of partial obstruction (35.3 years). The average duration of acute symptoms in 26 of the cases of acute obstruction, in which this detail is given, was three days and rather less in the 9 fatal cases than in the 17 cured cases. In the cases following appendicitis the time between the first operation and that for the obstruction varied from six days to sixteen years, and averaged a little over two years; in the pelvic cases it varied from two days to sixteen years, and averaged over two and a half years. The total mortality of the 48 operations was 37.2 per cent., that of the partial obstructions, 35 per cent., as compared with 38.7 per cent. in complete obstructions.

As to the pathology of the fatal result in cases where the condition is not relieved or relieved too late, we can readily understand the cause in septic or paralytic cases with peritonitis, and in cases of strangulation where the bowel becomes gangrenous, leading to peritonitis. Roger, of Paris, MacCullum, and others have found bacteria circulating in the blood in great numbers in such cases of obstruction in the ileum and colon.

In cases of mechanical obstruction without strangulation, the problem is more complicated. Absorption of one thing or another from the bowel contents has been generally credited as the important factor, but this is now disputed. Experimentally it has been found[7] in rabbits that there is no bacteremia in fatal mechanical obstruction when there are no bacteria in the peritoneal cavity, i. e., when there is no peritonitis. In such cases death was attributed to autointoxication from the decomposed intestinal contents. Thus, Nesbitt[8] found in the afferent loop of complete obstructions of the lower ileum the constant presence of neurin, if food containing much lecithin had been ingested. Others[9] have isolated putrescin in a stran-

Digitized by Google

gulated loop. The absorption of these and other very active poisons would account for the restlessness and great prostration in these cases, and explains the benefit of washing out the stomach or emptying the efferent loop. Treves has stated that the establishment of an opening in the bowel above an obstruction which has been found and relieved has reduced the mortality by fifty per cent.

But Braun[10] claims that this autointoxication is not the cause, and attributes the terminal sinking of blood pressure to an anæmic or asphyxiated paralysis of the basal brain centers due to the great stasis of blood which one finds in the abdominal viscera,—a bleeding, as it were, into the splanchnic region. This, he says, depends upon the irritation of the intestinal obstruction, and is increased by the exaggerated intestinal and glandular activity. He seems to be led to this view by the resemblance of the pulse and respiration curves to those in death from hemorrhage. The injection of animals with the poisonous intestinal contents gave results in no wise resembling ileus in its symptoms or the pulse and respiration curves. According to this view, the drainage of the bowel above the obstruction by an enterostomy works favorably, not by the removal of the poisonous intestinal contents, but by decreasing the circulation in the abdomen. F. T. Murphy's experiments have led to a somewhat similar conclusion, namely, that the collapse so often observed in severe cases is largely due to a vasomotor paralysis, in the production of which the obstruction of the venous flow seems to be the essential factor. These views as to the pathology of the fatal effect of obstruction are in some measure confirmed by Maury's[11] experiments on the cause of death in obstruction of the bowels within the first or oral 35 cm. from the pylorus. He found that the animals died just the same when the possibility of absorption of decomposed

Digitized by Google

food was eliminated by previous fasting and through purgation. He attributes the animals' death to absorption of toxins in the duodenal secretion, but as these toxins are neutralized by intestinal antitoxins if the obstruction is placed more than 35 cm. from the pylorus, this explanation applies only to cases of arteriomesenteric obstruction, and not to the cases of obstruction most commonly observed clinically. In all the several explanations drainage for the passage of the contents retained above the obstruction is of the greatest service therapeutically.

Diagnosis.—The diagnosis of mechanical obstruction occurring late, weeks, months, or years after the operation, is not usually difficult. There is pain coming on suddenly, with colicky exacerbations, more or less localized to the region of the obstruction, but often referred to the epigastrium; nausea with vomiting at once or after an interval varying with the distance of the obstruction from the stomach; no passage of fæces or flatus, or none after one or two passages emptying the bowel below the obstruction; increased peristalsis and in time increasing distension, often asymmetrical. There is usually tenderness, often localized, in the region of the obstruction. The temperature is not elevated at first, and may be subnormal and the pulse may be somewhat rapid or nearly normal. The leucocyte count and indicanuria are both increased, but are of little value, as they are increased in so many other conditions. The diagnosis is evident without these aids.

Can we distinguish between strangulation and obturation? In many cases, yes, but not always. The so-called "peritoneal shock" is an early sign of strangulation. In this condition the pulse is rapid, the surface pale and cold, the temperature subnormal, and the face is anxious. I have found the pain in strangulation much more intense and persistent and the ex-

Digitized by Google

acerbations more frequent than in obturation. But in practice, the differentiation is often very hard, especially as they may be combined even from the outset. Only in the subacute cases or those of partial obstruction, can there be any question between obstruction and a colic from other causes. The lack of a history of the ingestion of indigestible food or of a sudden chilling of the body, of a diarrhœa, of a lead line on the gums or of an occupation to warrant lead poisoning, of a history or signs of tabes, etc., enables us to make a correct diagnosis. In all these cases the history and scar of a previous abdominal operation are suggestive of the cause. A good rule to go by, if in doubt, is to perform laparotomy at once, if a moderate dose of morphine has to be repeated to control the pain.

Can we locate the situation of the obstruction? It is very desirable to do so, both with reference to the part of the intestine, and to its position in the abdomen. The abdominal scar helps us, but often not very precisely, for the obstruction may be at a considerable distance. The position of the initial pain, of the tenderness, and of the first appearance of distension, assist in determining the position of the obstruction. In thin subjects the exaggerated peristalsis can sometimes be seen, in stouter subjects be heard, to end at a definite point, but we cannot localize it quite so well by auscultation. The early or late onset and the frequency of the vomiting, and the character of the vomitus, help us in judging whether the obstruction is high or low in the bowel. Occasionally the distended loop of a strangulation or volvulus has been made out by inspection, by reason of the asymmetry of the abdomen, or by palpation by reason of its increased resistance (van Wahl's sign). But when all is said the diagnosis of the position of the obstruction is uncertain, and I have been mistaken when I felt quite sure of the site of the obstruction. In post-operative obstruc-

Digitized by Google

tion we know that the site of the obstruction is in the small intestine in, at least, 85 per cent. (Gibson), so that it is largely a question of high or low in the small gut. I have found the adhesions most often in the pelvis, even in cases following appendicitis. Hawkes mentions finding them most often at the inner side of the caput coli.

In *early cases,* those occurring in the first ten to fourteen days after operation, the diagnosis is not so simple, but is often obscured by conditions which necessitated or were present at the time of the previous operation, *i. e.,* infection, trauma, sequelæ of anæthesia, etc. If there was no peritonitis at the time of operation and no signs of any since, obstructive symptoms indicate mechanical obstruction except in the first day or two, when they may depend upon a post-operative intestinal atony.

In cases where peritonitis was present on operating, the conditions are more complex. We must here diagnose between spreading peritonitis and obstruction. Peritonitis itself, especially if it is spreading, gives many of the symptoms indicative of obstruction, pain, nausea, vomiting, etc., and the symptoms of the two conditions are so nearly identical that the diagnosis is often difficult and at times impossible.

In obstruction the pulse is quiet, full, and regular until the patient becomes toxic, the pain is more paroxysmal, the vomiting may be of larger amounts and less frequent, and there is little, if any, rise in temperature at first. If the initial rise of temperature of the peritonitis has approached the normal after operation, a further rise of temperature at the onset of the obstructive symptoms indicates a peritonitic cause, *i. e.,* a spreading of peritonitis or a localized secondary abscess. The leucocyte count, differential as well as general, is of doubtful value, but a low count helps to exclude inflammation and it is

Digitized by Google

not as likely to rise or be as high in obstruction as in peritonitis. According to Javel[12] facies abdominalis, as an early symptom, speaks for peritonitis or strangulation and one of the earliest signs of peritonitis are hyperæmic spots on the forehead. Frequent micturition suggests a local peritonitis, and restlessness and excitement indicate peritonitis, though, in my experience, they are quite as characteristic of obstruction. Javel also affirms that a general peritonitis can progress with a normal frequency of pulse. Rigidity is a most important sign of peritonitis, but may be wanting when the patient becomes very toxic. Furthermore, in most of the class of cases under consideration, obstruction, if present, coexists with peritonitis, so that the diagnostic requirement is to distinguish between peritonitis alone and peritonitis plus obstruction. Constipation is the main thing. This, or the reverse, may be present in peritonitis, but gas or feces are likely to be passed after enemata; not so in an obstruction which does not yield. If repeated enemata of various kinds, and perhaps the moderate use of cathartics, are not followed by the passage of gas or fæces, and especially if other signs of obstruction are also present, such as colicky pain, vomiting, distension, etc., we should diagnose and treat the case as one of obstruction for the safety of the patient.

Again the question arises after diagnosing an early post-operative obstruction, where peritonitis is or has been present, can we distinguish between the mechanical and the paralytic forms? This is very essential as the former is very amenable to operative treatment, the latter much less so. It is often difficult and in many cases impossible to differentiate between them. The sudden onset of pain is indicative of volvulus or strangulation. The pain is more severe and persistent in mechanical obstruction than in the paralytic form. Corre-

Digitized by Google

sponding to this we find that the peristalsis is much increased in mechanical and diminished in paralytic obstruction. In mechanical obstruction the patients may assume peculiar positions to relax the abdomen and its viscera, while in paralytic obstruction they lie more quietly on the back with the knees drawn up. Vomiting comes on later in mechanical obstruction, unless it is in the upper bowel, and in the paralytic form there are more frequent regurgitations of a dark fluid from the stomach. Distension, too, may be more marked, and more uniform in paralytic obstruction. After all is said, it may be impossible in the individual case to diagnose the mechanical from the paralytic form and we must be guided by this fact in the treatment.

In all cases of post-operative obstruction, the possibility of an acute dilatation of the stomach or arterio-mesenteric ileus, should not be forgotten. In my experience, this is of more common occurrence than generally recognized. It may come on with a sudden or a more gradual onset in the first few days after operation. There may be acute or diffuse abdominal pain in the early stages. Vomiting of large quantities of yellowish or greenish, sour-smelling fluid at frequent intervals, with little or no effort, distension of the upper abdomen, rapid pulse and respiration, and normal or subnormal temperature, great restlessness, an anxious expression, great prostration, intense thirst, scanty urine, and constipation, are the principal symptoms. The constipation is not absolute, flatus is often passed after enemata, and occasionally watery stools have been observed. There is usually succussion over the stomach. There is little or no tenderness, rigidity, or leucocytosis. The use of the stomach tube will confirm the diagnosis. It would seem that the diagnosis would be easy, but experience in the past has proved otherwise. However, if one has once seen the con-

Digitized by Google

dition and has it in mind, I do not think the diagnosis is difficult. The causative effect of prolonged narcosis has been mentioned by several writers, and in the first case in my experience in which the condition was recognized, the patient had been under the influence of chloroform for two days before operation on account of intense pain, not relieved by morphine. This case yielded to treatment.

Finally, it must not be forgotten that exceptional cases of post-operative obstruction are lacking in some or several of the characteristic symptoms of that condition. Thus, Rogers reports a case where there was gangrene under a band in the jejunum without any pain, rigidity, or distension.

Treatment.—This resolves itself into prophylaxis and treatment proper, of which the former is fully as important as and often more successful than the latter.

Prophylaxis.—Can we avoid post-operative obstruction or lessen the frequency of its occurrence? Practically all cases are due to sepsis, operative trauma, or adhesions. The problem, then, is to prevent or lessen the frequency of the occurrence of these three factors. If the rule of operating for appendicitis in practically all cases as soon as the diagnosis can be made were generally followed, most cases of septic or paralytic obstruction would be avoided. In the presence of septic peritonitis a rapid operation, avoidance of trauma to the peritoneum, the use of the continuous drip enema and the Fowler position, the avoidance of food or catharsis by the mouth, and the employment of milk and molasses and similar enemata to relieve distension, will cure most cases of spreading peritonitis and prevent the occurrence of paralytic obstruction. An intravenous saline infusion helps in the elimination of the toxins, and is an excellent stimulant, thus serving a double purpose.

Digitized by Google

After evacuating some of the pus of a septic peritonitis at the operation, the introduction of sheep serum or, better still, the concentrated antiferment serum (ascitic fluid, etc.), may be effective in checking the peritonitis and preventing septic ileus.

A nearly opposite plan is employed and advocated by some. Thus, Heile thinks early bowel movement gives the best result and tries to excite peristalsis directly after the operation so as to distribute the germs, increase the hyperæmia of the peritoneum and the autolysis and resorption of the pus. To this end he injects 50 to 100 c.c. of warm castor oil into the intestine during the operation, and the next day he employs enemata, physostigmine, etc., energetically, until a good result is obtained. He also uses a saline infusion, and claims that his mortality has been much lowered by the use of this method. Along the same lines, McCosh formerly employed and advocated an injection of mag. sulphate into the bowels during operation, and I have used it in a few cases. As these cases were among the worst of their kind, it is difficult to estimate the value of the method.

Several report the use of eserine (physostigmine) salicylate, given prophylactically, before and immediately after operation, and claim good results. Among German surgeons atropine has been similarly used quite a good deal, but many condemn it. I confess that I like to see the bowels move early under certain circumstances in septic peritonitis, *i. e.*, when distension is marked and increasing. Not only is meteorismus an indication at times of intestinal paralysis, but it may of itself cause it. When distension is marked and increasing, I employ lavage and give an enema of milk and molasses, p. e., or one containing ox gall, spirits of turpentine, and emulsion of asafœtida, or sometimes one containing alum, repeating

Digitized by Google

these if needed. Hot stupes to the abdomen are also useful. Often great quantities of gas are passed, perhaps there is a good fæcal result as well, and the condition is relieved. But if the distension quickly recurs, or is not relieved at first, I have several times used one-sixtieth to one-thirtieth grain physostigmine salicylate hypodermically, repeating it q. 2 h. for two or three doses, and the result has not infrequently been very satisfactory. I have never seen any bad results, and have never used it as a routine treatment. Too great faith in physostigmine or atropine interferes with careful diagnosis, and postpones more effective treatment.

It is in cases of post-operative intestinal atony that this treatment with physostigmine is most clearly indicated. This atony is largely due to the handling of the intestines and is normally temporary, but I have several times seen it lead to great distension which increases the paralysis, and leads also to angulation.

It is in the early period of distension that the use of physostigmine, combined with enemata and lavage as above described, works like a charm, and the entire aspect of the case is changed in a very short time. There may or may not have been peritonitis of moderate extent present when the case was operated, and the appearance on the second day p. o. is that of obstruction or a condition very close to it, with distension, vomiting, pain, restlessness, and no passage of flatus or fæces. The result of the above treatment in such cases is often most satisfactory.

As it has been shown by Cannon and Murphy that this local post-operative paralysis is largely due to handling—even the gentlest handling, of the intestines, and that its duration is in proportion to the amount and roughness of the handling, it follows that there should be as little and as gentle handling of

Digitized by Google

the bowels during operation as possible. These experimenters showed that unusual cooling or exposure to the air of the bowels, under aseptic precautions, and a long etherization of the animal, produced no appreciable paretic effect on the bowels.

Since employing the above plans of treatment I seldom see early post-operative obstruction due to septic or post-operative paralysis.

I agree with Peck[18] that careful post-operative treatment is of the greatest importance in the prophylaxis of obstruction. Not infrequently, an attack of indigestion and the formation of gas distending the bowel already adherent, perhaps paretic, and partially obstructed, will induce an attack of obstruction which might have been averted if the patient had been carefully watched, warned, and dieted in the first few weeks of convalescence.

Adhesions are a most prolific source of obstruction. What can we do to prevent them? As they are likely to form in an attack of acute appendicitis and are more widespread the more diffuse the peritonitis, we should advise operation as soon as the diagnosis is made or, at least, in the first interval, and not wait for several attacks. I have recently operated on two patients with obstruction due to adhesions from appendicitis not operated upon. For the same reasons other intraperitoneal inflammations should be operated upon without undue delay.

The technique of the operation affects very materially the formation of adhesions. Rough handling and mechanical irritation, drying by exposure to the air, contact with chemical irritants (antiseptics), and the introduction of foreign bodies (drains), promote the formation of adhesions, and should be avoided as much as possibly by careful attention to the technique. We no longer use antiseptics on the peritoneum. As

Digitized by Google

Baisch's experiments lead to the conclusion that adhesions depend upon blood in the peritoneal cavity, careful hemostasis is very desirable.

A fruitful source of adhesions is drainage. The use of drains is avoided altogether if we operate early enough. No gauze drains should be used unless covered by rubber tissue or tubing. Dr. F. T. Murphy has demonstrated that gauze drains are walled off by adhesions more rapidly than glass or rubber tubing or rubber-tissue wicks, and that a cigarette drain does not drain the general peritoneal cavity after eighteen hours. Hence, drains should be avoided if possible, they should not be left in long, and they should be of a non-irritating substance, rubber tissue or tubing unless the object is to wall off a local septic process. Moreover, the position of the drains is a matter of primary importance. As far as possible they should be bounded on one side by parietal and on the other side by visceral peritoneum and not on all sides by the latter, to diminish the chances of obstructive adhesions. Hence, if in a case of appendicitis with peritonitis, it is necessary to drain the pelvis, the drain should pass down outside the caput coli, between it and the iliac fossa, and not to its inner side among the intestinal coils where the adhesions will bind these coils together and to the cæcum. In the pelvis a barrier of omentum may be used to protect the intestinal coils. The removal of a drain internal to the cæcum is also more apt to twist or displace the contiguous coils. Hence, for drainage the muscle splitting incision is better than the Kammerer.

As absorption of adhesions occurs earlier and more evenly if the focus of infection is removed, the appendix should always be removed if possible. I cannot agree with the statement made that mechanical obstruction is more often due to appendicitis not operated upon than to appendicitis operated upon,

Digitized by Google

because the focus is not removed in the former case. For obstruction is not due so much to the number or firmness of the adhesions, as to adhesions which hold the bowel in an abnormal position. For this reason, we should avoid as far as possible, the displacement of the intestines during operations or, at least, we should try to replace them by floating them into position or otherwise, and prevent their adhesion to the wound and to raw surfaces by interposing omentum.

As areas denuded of peritoneum invite adhesions of the firmest kind, they should be covered by peritoneal suture, omental graft, etc., as far as possible. As after any intraperitoneal operation, especially if there is much handling or exposure of the bowels, adhesions are liable to form, many have attempted to solve the problem of preventing or minimizing these adhesions, but with only partial success. The prevention of post-operative adhesions is mainly a matter of general technique and not of any one procedure or remedial agent. Rigid asepsis; prevention of cooling or drying of the exposed parts by the use of hot salt solution, by keeping them covered, and by rapid operating; avoidance of undue handling, by proper position, etc., and of unnecessary packs and pads; avoidance of raw surfaces by covering them with peritoneum or omental grafts; early establishment of peristalsis and catharsis by enemata, physostigmine, etc.;[18] frequent change of position after operation; these and perhaps other similar measures may, under ideal conditions, assist in avoiding adhesions, save perhaps the very finest, and they are soon dissipated by peristalsis. But most operations do not offer such ideal conditions, or the problem may be to prevent the re-formation of adhesions that have had to be broken up during the operation.

Can we prevent the re-formation of existing adhesions? Not with our present knowledge. The best we can do is to

Digitized by Google

minimize them. This problem has been approached experimentally, and various methods tried on animals and then on the human subject. The variety of methods used and of substances interposed between raw surfaces to prevent their adhesion by fibrin and later by fibrous tissue is very large, and we can only enumerate them. Normal salt solution floats the bowels well into place, but does not separate them—they merely float on it. Cargile membrane, collodion, and a film of aristol fail. Charring by the cautery prevents, milder cauterization produces adhesions, but the former is not often applicable. Thiosinamine or fibrolysin to soften or dissolve adhesions; phosphorus by mouth, and peptone hypodermically to prevent the formation of fibrin and thereby the agglutination of opposed serous surfaces; non-irritating fats and mucoid substances, such as olive oil, paraffin, tallow, lanolin, agar, gelatin and mucilage, to form an even thin coating on the serous surfaces, have all been tried and some have found enthusiastic supporters. But unbiased opinion is to the effect that no one is a panacea, though some have a certain value. Blake, of Boston, in a paper before this association, reported experiments in the use of sterile olive oil and concluded that it was harmless in moderate quantity, and that the adhesions were fewer and less dense. Hoehne[14] recommends Glimm's method of injecting 30 c.c. of sterile 10 per cent. camphorated oil into the peritoneal cavity to prevent peritonitis and incidentally adhesions. Gellhorn[15] speaks encouragingly of lanolin, but the best results have apparently been obtained by the use of a thick mucilage of gum arabic. In cases where adhesions have formed, especially where there seems to be an idiosyncrasy to the formation of firm adhesions, I would advise the trial of thiosinamine or fibrolysin.

The treatment of actual obstruction is operative.

Digitized by Google

Late Obstruction.—The chances of palliation are slim and many of the adhesions have disappeared so that the operation is easier. If we can diagnose the variety and position of the obstruction, the operation is much simplified. The incision is made over the site of the obstruction. Otherwise the laparotomy must be in the first place exploratory. In such cases the incision must be ample for exploration and is made to the median side of the scar or in the median line. The collapsed and distended portions of the intestine are the best guide to the site of the obstruction, which is almost always in the small intestine. In all cases the operation must be performed as soon as possible after the diagnosis is made, after a reasonable attempt has been made to move the bowels by repeated enemata of milk and molasses, or enemata containing glycerin or ox gall, asafœtida, and spirits of turpentine. Often cathartics have already been given, but of course these should never be persisted in.

After the site of the obstruction is found the cause must be relieved, adhesions or bands severed between two ligatures, a volvulus untwisted and its predisposing cause, bands or adhesions, narrowing the base of the loop relieved. If the viability of the intestine, in case of strangulation or volvulus, is questionable, the affected intestine should be covered with pads wet with hot saline solution. If the circulation returns in ten or fifteen minutes, and there is no line or area which appears necrotic, the incision may be closed; otherwise, immediate resection of the necrotic area and anastomosis, end to end or side to side, is preferable to an artificial anus, if the condition of the patient justifies it. In some cases if the viability of the gut at the site of a constricting band is doubtful, omentum may be sutured over it. Obstructive adhesions have formed at the site of the appendix whether the stump is inverted or cauter-

Digitized by Google

ized. When there is much matting together by adhesions with obstruction, Deaver recommends lateral anastomosis of the afferent and efferent loops, but I have not found the conditions present that would demand such a procedure.

The indications for treatment are not so clear in *early obstructions*. Most of them depend upon sepsis, but some are due to mechanical causes or to both causes combined. The later it occurs after operation the more likely is a mechanical element to be present. In early cases the onset of the trouble is masked by phenomena that we are wont to meet with after laparotomies, especially the vomiting and pain. If the vomiting is unusually prolonged, it is often attributed to increased sensitiveness of the stomach or to some idiosyncrasy. The surgeon hesitates and employs palliative treatment, he does not want to believe that the complication exists, and dislikes to propose a second operation, and thus he loses the opportune moment. The patient is very restless with an anxious expression or, from the septic intoxication, becomes lethargic and complains of little but frequent vomiting or gulping of a brownish fluid. The abdomen is distended and the pulse and respiration are much affected by it. Peristalsis is very weak or wanting. The condition rapidly deteriorates and the chances of a successful operation are desperate.

In these cases we must begin early. Lavage should be done where the vomiting is frequently repeated, or is continued beyond the first twenty-four or thirty-six hours. In some cases with continued vomiting, especially where the distension begins in the epigastrium and is later most marked there, I have several times seen repeated lavage, together with turning the patient on the stomach (or knee-chest position), result in wonderful improvement and ultimate recovery. These are cases of acute dilatation of the stomach or arterio-mesenteric ileus.

Digitized by Google

In all of the cases described above the stomach tube is of great service, and in addition, I use enemata, stupes, physostigmine, etc., as described above. Electricity applied through an electrode in the rectum has been successfully used, but I know nothing of it. If a little gas or gas and fæcal matter passes, this line of treatment is persisted in. If more gas, etc., passes and the distension begins to relax, the adynamic obstruction is often relieved.

If palliative treatment is not effective in the first few hours, operation should not be long delayed, and ileostomy or an exploratory operation must be done. If the trouble comes on some days after operation, if pain is a prominent symptom, and especially if it is paroxysmal or localized and if peristalsis is active, a mechanical cause is to be suspected and laparotomy done, if the patient's condition justifies it. In one case four days after operation, I found a mass of omentum riddled with pus pockets, causing obstruction by its pressure, and its removal was followed by a speedy cure.

If, on the other hand, the symptoms are more those of a septic ileus, ileostomy is indicated. In the most desperate cases this may be done through the opened-up wound. These cases and those where the patient's condition only allows an ileostomy under local anæsthesia, almost always die, in my experience. We must not wait until so late. An earlier laparotomy allows a rapid exploration and perhaps the discovery of a mechanical cause or an overlooked secondary abscess. The latter condition must always be looked for, especially after the first few days. But one must avoid trying to do too much. A tube fastened in by a purse-string suture, inverting the surface of the bowel, is water-tight. Through it we may employ repeated irrigation and syphonage of the bowels. This is more effective than simple enterostomy, for it thins the bowel con-

Digitized by Google

tents and adds syphonage to abdominal pressure to empty the bowels, which are paretic and have little power to empty themselves.

The stomach should be washed out before operation to avoid the danger of aspiration pneumonia and of asphyxia from the vomitus. For the same purpose the operation may be done under local or spinal anæsthesia.

Elsberg[16] has presented the case of enterostomy strongly, claiming that only a small per cent. of cases of obstruction are in a condition to justify radical operation, and that in the worst cases and in the large midway class, enterostomy is the best treatment. As to the objections (1) that the cause is unrelieved, he cites two cases to show that it may be relieved by enterostomy alone, and says that if found at once, it may often be safely relieved, but even where it can be relieved, it is often better to save life by enterostomy and relieve the cause later. The objection (2) that a fæcal fistula may remain and require a second operation does not hold in the technique given above. As to the objection (3) that the gut may be or become gangrenous, his statistics show that only 5 per cent. of acute obstructions, besides intussusception and volvulus, present gangrene. Enterostomy may prevent threatened gangrene, while if gangrene is found the loop may be brought out of the wound. The danger of leaving gangrenous gut behind is less than that of prolonged manipulations. His results with enterostomy are much better than those I have seen, because the operations were done earlier and not so exclusively as a last resort. McWilliams in reporting statistically on the 1,400 cases of appendicitis operated on in the Presbyterian Hospital, in the last five years, found twelve enterostomies, with a mortality of 83 per cent. Enterostomy is mostly employed in the bad cases of paralytic obstruction. It is inadvisable in early and mild cases,

Digitized by Google

but if enterostomy is done, it should be done earlier than I have seen it done, to get satisfactory results. Multiple enterostomy, with drainage at one or more openings, has proved valuable in the hands of some.

In septic or paralytic obstruction, more than in any other form, prophylaxis is far more important and successful than operative treatment at a later stage. In my experience the general recognition by the profession of the importance of early operation, the improvements in technique and careful prophylaxis, have rendered this most hopeless class of cases of post-operative obstruction very much less common than formerly.

REFERENCES.

[1] Peck. Anns. of Surg., 1904, XL., p. 510.
[2] Hawkes. Anns. of Surg., 1909, Feb., p. 172.
[3] Fischer. Deut. Zeitschr. f. Chir., v. XCIV., p. 107.
[4] Israel. Cblatt f. Chir., 1903, p. 1378.
[5] v. Stockum. Ref. in Cblatt f. Chir., 1902, p. 259.
[6] Schönwerth. Deut. Med. Wochschr., 1909, No. 27.
[7] A. v. Khantz, Jr. Archiv. f. Klin. Chir., Bd. 88, hft. 2.
[8] Nesbitt. The Journ. of Experiment. Med., 1899.
[9] Kukula. Archiv. f. Klin. Chir., bd. 63, p. 773.
[10] W. Braun and H. Boruttan. Deut. Zeitschr. f. Chir., bd. 96, p. 544; and W. Braun, Cblatt f. Chir., '09, p. 1155.
[11] Maury. Journ. Am. Med. Assn., vol. LIV., p. 5.
[12] Javel. Rev. de Chir., XXIII., Nos. 8-10 and 12.
[13] Ward. Am. Journ. of Obstet., v. XLIII., p. 753.
[14] Hoehne. Münch. Med. Wochenschr., LVI., No. 49.
[15] Gellhorn. Surg. Gynecol. and Obstet., v. VIII., p. 509.
[16] Elsberg. Anns. of Surg., XLVII., p. 737.

Digitized by Google

Digitized by Google

XIX.

INTESTINAL DIVERTICULA.*
A PATHOLOGICAL AND CLINICAL STUDY.

By John A. Hartwell, M.D., Assistant Visiting Surgeon,
and
Russell L. Cecil, M.D., Assistant Visiting Physician.

The condition known as diverticulum of the intestine has been recognized as a pathological entity for more than a hundred years, but knowledge of its relation to perforative peritonitis is of recent date, and up to the present time few cases have been operated upon in which a pre-operative diagnosis was made. Cases, however, in which this condition proved to be the underlying cause of a peritoneal infection have multiplied of late, so that its complete analysis is a matter of interest, both to the scientific investigator and to the practical physician and surgeon.

The term diverticulum of the intestine may be applied to any outgrowth of the intestinal wall, not neoplastic in character, which has had at some time a lumen connecting it with the intestine, and whose walls are composed of structures similar to those found in the intestines. Under this definition, Meckel's diverticulum is included as a congenital anomaly, and the appendix vermiformis as a normal vestigial diverticulum. When the outgrowth is composed of all the structures which are found in the normal intestinal wall, it is called a true diver-

*(*Reprinted from the American Journal of the Medical Sciences, August,* 1910.)

Digitized by Google

ticulum. When some of these structures are absent, it is called a false diverticulum. That the former may become the latter, must be recognized.

The older classification into congenital and acquired diverticulum serves no useful purpose, and should be discarded, because with our present knowledge we can draw no distinguishing line between the two, except in the case of Meckel's diverticulum and the appendix; and we believe, as will develop later, that most, if not all, cases of diverticula have at least a congenital predisposition.

The structure of a diverticulum, when not inflamed, is very simple. If of the true variety, it is nothing other than the pouching out of the intestinal wall at some point. A section across the pouch shows the same coats arranged in the same way as in that part of the intestine of which it is an outgrowth. If of the false variety, the individual coats are more or less modified, and there is a practical absence of one or more of them, usually of the two muscular layers. In their early development, they are microscopical in size (Graser,[1] Fischer[2]), and show at this time the characteristics of the true diverticulum. With their growth, however, the false characteristics come into evidence. If no inflammation supervenes, the structure remains unchanged during a considerable growth, so that the diverticula, varying in size from a buckshot to a hen's egg, may be seen presenting the simple structure above described. On the other hand, a varying amount of atrophy, particularly of the mucosa, may take place, and a hypertrophy of the submucosa and the subserosa. These changes are not, properly speaking, inflammatory, but are due to pressure. If no further alteration take place these diverticula do not give evidence of their presence by any clinical symptoms, in this respect resembling a Meckel's diverticulum and the appendix vermi-

Digitized by Google

formis. If, on the other hand, inflammatory changes do take place, there are present exactly the same factors for producing mischief as exist in the appendix and Meckel's pouch.

Until recent years it was believed that these diverticula are rare. Now, however, they are known to be common, and with this knowledge has come the further knowledge that they are the seat of great potential danger to health and life. In making a systematic search, Graser found 10 cases in 28 autopsies; Sudsuki[3] found 15 in 40 autopsies; Stierlin (quoted by Verdenal[4]) found 10 in 38 autopsies. These were all in the lower colon or sigmoid. Baldwin[5] has found 14 diverticula of the duodenum in a systematic search of 104 cadavers in the anatomical room of the Cornell Medical School. In 81 autopsies done at the Presbyterian Hospital, in New York City, from June, 1909, to February, 1910, 5 cases of sigmoid- and colon-diverticula are recorded, all of a well marked size.

Intestinal diverticula have been found in every portion of the alimentary tract, from the pylorus to the anal ring. The duodenum has furnished a large number (Baldwin); the whole small intestine has shown them; the appendix vermiformis itself has not escaped (Fischer Mertens[6]), and they have been found in large numbers in the colon and the sigmoid. The infection producing ischio-rectal abscess may find its way from the bowel through a diverticulum (Chiari[7]), though the latter is rare in the lower rectum. Apparently the sigmoid is the favorite site for their development. This may be accounted for by the fact that the secondary causes in their production, as elaborated later, are more potent here than in other parts of the bowel.

Their comparative absence in the rectum proper is interesting and is ascribed by Schreiber[8] to the better musculature in this part. The total number found in one person may run

Digitized by Google

high up in the hundreds. Structurally, they are the same no matter in what portion of the canal they are found, and there is no evidence that the etiological factors differ. In looking for their cause, therefore, we must accept only such conditions as are present along the whole intestinal tract, and such factors as do not conform to this condition must be excluded as primary causes.

A very large proportion of the diverticula of the small intestine occur either between the mesenteric leaves or close to them (Fig. 1), and this fact led to the belief that there existed an inherent weakness here which was responsible for the hernial protrusion. The colon, however, often shows them placed laterally (Fig. 2). Herczel[9] and Good[10] showed that bulging of the intestinal wall first took place at the mesenteric border when the dead intestine was subjected to increased pressure within its lumen by distention with water. Hansemann[11] succeeded in producing actual diverticula. It was noted, however, that the weakness was present only in old persons, and not in children. Klebs, quoted by Beer in a study of diverticula, first noted that the protrusion bore a close relation to the blood vessels entering and leaving the gut along the mesenteric attachment. This fact has been corroborated by every subsequent observer, and it was noted that the same relation held in the artificially produced bulgings.

These pathological and experimental findings were made the basis of a full explanation of the etiology of diverticula, as follows: The mesenteric border is weak; it is weakest at the point of entrance and exit of the vessels, particularly the latter; this weakness naturally increases with age; a comparatively moderate increase in internal pressure determines the giving away of the wall at one of these points, and the diverticulum is an accomplished fact. The constipation of the old

Digitized by Google

FIG. 1.—Diverticula of the small intestine. The diverticula all occur along the mesenteric attachment. (Case XVIII.)

FIG. 2.—Diverticula of the colon. The diverticula lie between the lateral tenia and the mesenteric attachment. (Case XVII.)

Digitized by Google

Digitized by Google

was given as the cause of the increase in pressure. This explanation was complete for the condition as then understood. Further consideration, however, throws much doubt on it. Chlumsky[12] showed that no conclusions drawn from experiments on the dead gut were admissible as explaining facts existent in the living gut. He experimented with the normal intestine in the living dog, and with the intestine ten hours after death. In the former the rupture took place invariably opposite the mesentery, while in the latter, along the mesenteric border. Moreover, Philipowitz[13] demonstrated that the dead intestine ruptured long before it had been distended to anything like the extent seen in the living subject in volvulus and other forms of obstruction. Beer[14] quotes these findings and uses them as arguments against the supposed inherent weakness along the mesentery. He further calls attention to the fact that clinically, rupture of the intestine, from whatever cause, almost invariably occurs opposite the mesentery. He explains the difference in the results in the living and in the dead intestine as due in the first instance to the pressure of the blood stream filling the vessels and thus closing the spaces of entrance and exit, while in the latter, that is, the dead gut, the empty vessels leave a place of lessened resistance around them. He says: "The supposed weakness of the mesentery—in the living intestine—does not exist, and as it does not exist, it has nothing to do with the origin of acquired diverticula."

Graser investigated the subject most thoroughly as applied to diverticula occurring in the sigmoid. He found the same relation to the vessels as other observers; that is the hernial protrusion follows the emerging vein and often takes a wandering course through the intestinal wall finally to reach the subserosa.

Digitized by Google

In this passage the circular muscular coat first gives way and the longitudinal follows later, or may only be thinned out. He then sought for the actual cause of the diverticulum and thought he found it in the presence of any obstructive lesion to the free return of blood through the inferior mesenteric vein, particularly where, as in valvular heart lesions, the interference might be remittent. Under these conditions when the obstruction is marked the spaces through which the veins pass are dilated and the connective tissue and muscular bundles weakened. With the comparative collapse of the veins, when a free circulation is re-established, the spaces present a point of lowered resistance, and a gas or liquid pressure from within starts the development of the diverticulum. By a careful study of twenty-eight cases, from which he made over a thousand sections, in series, he believed he fully established this relation. He, however, pointed out the fact that the circulatory disturbance was only a predisposing cause, and that diverticula were not necessarily present in every case having such a disturbance.

Graser's view was opposed at the time he presented it, by Hansemann and others, and a year later Sudsuki made a study to prove its error. He examined, post-mortem, twenty-eight sigmoids taken from patients who in life had suffered from interference with the venous return in the region of the inferior mesenteric vein, and found diverticula present in six of them. On the other hand, in twelve cases in which no evidence of such an interference existed, he found diverticula present nine times. He further showed that the size of the vein sheaths was independent of any obstructive lesion during life, the space often being distinctly larger when no such obstruction existed than it was in those cases in which it did exist. He concludes that Graser's findings were purely accidental, and that no causative relation exists between a circulatory disturbance and a

Digitized by Google

diverticulum. He believed that the venous sheaths may be a point of weakness because of the thinning out of the connective tissue support in the subserosa and submucosa. This weakened point then gives way under the pressure of gas and feces, and the diverticulum results. Probably in the beginning it is of the true variety, but later the muscular coats give way, and it becomes false in character.

This explanation of the etiology may be accepted, in part at least, for those diverticula which are found near the mesentery where the veins are emerging, but, as Beer points out, it does not hold for those which occur on the convex side of the bowel. He, therefore, only accepts the weakening of the wall due to the passage of vessels through it as of secondary importance in a causative way. He offers the following explanation of the cause of diverticula: "There must be some change in the resistant powers of the gut wall. The fact that diverticula occur in old people, in people whose intestines have been more or less worked out, as evidenced by constipation, points to a muscular deficiency, and in this muscular weakness, the cause of the formation of false diverticula must be sought." * * * "It is very probable that the original view of Klebs is, in part, correct, especially with reference to the production of the diverticula in the small intestine, and that traction on the gut by the mesentery is a factor in the production of the necessary weakness at this point, where these diverticula so regularly occur in the small intestine. That this traction is a reality can be easily demonstrated by distending loops of intestine *in situ,* or by noting the enormous tension of the mesentery in ileus cases. Naturally, in those parts of the intestine where no mesentery exists, this cannot be a factor."

That Beer's view is correct, so far as the pathological changes which lead to the diverticulum are concerned, we are

Digitized by Google

willing to accept; but that he is incorrect in the primary cause of this change, namely, weakened musculature, due to age, is manifest from the fact that diverticula are found in children and young adults.

Ashhurst[15] has reported a case in a boy of seven, and two of the cases reported in the present series occurred in children of seven and ten years, respectively (Figs. 3 and 4). A number were found in persons under thirty. In none of these was there clinical evidence of deficient muscular activity of the intestine. The following observation too, is of value in this connection. An examination of the colon from five infants who had died from various infantile diseases was made for the purpose of demonstrating the presence or absence of points of weakness in their walls. The colons were moderately hardened in formalin, and then filled with water just sufficient to render the walls taut, but not under enough pressure to stretch them. In three of the cases there was some evidence of a weakness at one or more points, while in two such evidence was absent. In each of the positive cases there occurred a slight outpushing of the wall of the intestine, about 1 cm. in diameter, which had somewhat the macroscopic appearance of the small diverticula seen in adults. The wall over the fundus of the sac seemed to inspection and palpation distinctly thinner than in other parts of the gut. Microscopically, in sections taken transversely through the guts at the points described above, the muscularis appears definitely thinner than in the adjacent gut wall.

We, therefore, are driven to the conclusion that up to the present time no complete explanation of the primary cause of intestinal diverticula has been offered. The most that can be said is, that from some cause a weakness exists in the intestinal coats, and by reason of this weakness, a pouching of the

Digitized by Google

FIG. 3.—Piece of colon obtained from a boy, aged six years. In one of the haustra, two diverticula can be seen, one on either side of the anterior tenia. (Case VII.)

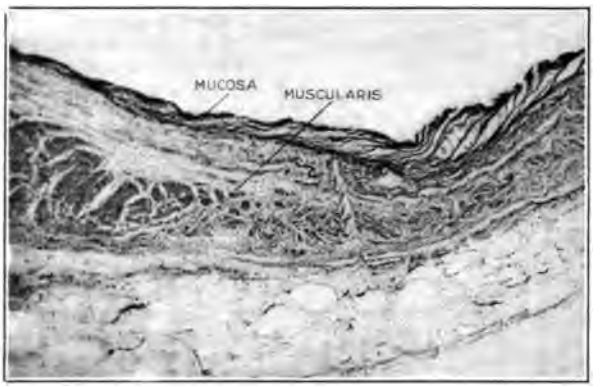


FIG. 4.—Microscopic section through a diverticulum in the sigmoid of a girl aged 10 years. The mucosa is flattened. The muscularis becomes thin and atrophic, almost disappearing over the fundus of the sac. (Case VIII.)

Digitized by Google

Digitized by Google

coats takes place when any undue pressure arises. Conditions such as age, constipated habit, excessive fat or emaciation, portal congestion, the anatomical weakness at the point of entrance or exit of vessels all play an undoubted role, but they are probably secondary to the inherent weakness above mentioned. Telling,[16] in a very able discussion of the condition, based on a study of 105 cases, leaves the question of etiology unsettled. In speaking of this, he asks: "Are they always acquired?" and says: "In answer to this question, it is significant that no case has been reported in a child (Hale White, Schreiber)—(this we now see is incorrect)—while the great majority are in the old, even aged, subjects. Moreover, the various points which have been successively established with regard to their etiology would seem to put the answers to this question beyond doubt, even though we admit that a congenital anatomical arrangement of the muscle fibers, or of the connective tissue of the vessel spaces of the gut wall furnishes a special predisposition." "Whether this muscular weakness and thinning is a constant or frequent accompaniment, or whether it is a congenital or acquired condition, are points on which further research is needed."

It seems to us that great stress should be laid on the probability that a congenital defect in the musculature does exist, and that most diverticula occur because of this defect. Contrary to the expressed view, that young persons are not subject to them, as we have stated, there are many recorded cases in patients under thirty, and not a few in young children. Moreover, Edel,[17] Fischer, and others, as well as the specimens here presented, give strong evidence that in the first stage all diverticula are of the true type, and that only subsequent pressure destroys the muscular coats, showing that the muscular coats previously exhibited a weakened condition. The conditions

Digitized by Google

found in the infant colons above referred to is very significant in this connection.

The pathology of intestinal diverticulum needs to be considered under two distinct conditions: its pathology when uncomplicated by secondary changes, and the pathology when such changes have intervened. A detailed study of this has been made by us on the material at our disposal, and is reported in full. Emphasis will be laid at this time only on those points which are of clinical significance.

It must be borne in mind that the diverticulum itself is absolutely a harmless condition as far as the health of the individual is concerned. Of the specimens reported in this paper, eighteen in number, four were the cause of symptoms during life. In each one of these the symptoms were due, not to the actual diverticulum, but to the secondary changes occurring from it. Telling names eleven possible conditions which may give rise to symptoms, and illustrates each one of them by one or more of the cases which he summarizes. Some of these are so nearly related, the one to the other, that they may be considered modifications of the same process, and their separation seems to confuse rather than to simplify. A practical working classification of the secondary changes which give rise to symptoms is one which is in every way comparable to those occurring in the case of the appendix.

1. There may arise an acute inflammation of the diverticulum without perforation, which results in a peritonitis or a cellulitis around it. Loomis[8] reports one case in which general peritonitis so resulted. The formation of adhesions to neighboring parts may cause an obstruction, more or less acute, either at the site of the diverticulum or in a loop of gut adjacent to it.

Digitized by Google

2. The inflammatory process may cause destruction of the coats of the diverticulum when a perforation results, leading either to a localized abscess, a general peritonitis, a general blood infection, or all three. The perforation may communicate with other hollow viscera, notably the bladder. Telling cites a case showing submucous perforations, so that fistulous tracts formed within the intestinal wall.

3. The diverticula may become the seat of a mild, subacute, or chronic inflammation, which does not produce marked changes. This condition is subject to temporary exacerbations and remissions. (Giffin,[19], Mayo.)

4. A chronic inflammation may occur in the diverticulum which leads to thickening of the walls of the diverticulum itself, and from the irritating effect of the toxins in the lymphatics and venules, the process spreads to the surrounding tissues, resulting in thickening of the whole intestinal wall and of its mesentery. When multiple diverticula are present, a long piece of the gut may be involved. Here, again, adhesions may lead to intestinal obstruction, or this obstruction may result from narrowing of the lumen. Here, also, a chronic perforation may take place.

5. Carcinoma may develop on the diverticulum. Hochenegg,[20] Wilson and Giffin.[21])

Comparing these changes with those of the diseased appendix, we find them exactly analogous: that is, acute inflammation without perforation; acute inflammation with perforation; subacute and chronic inflammation without marked thickening; chronic inflammation with marked thickening; and carcinomatous development. The question naturally arises as to what is the cause of these changes. In the majority of cases they are probably due to the irritation caused by the fæcal concretions in the intestines. For this reason the secondary

Digitized by Google

changes are almost invariably found in the large intestinal diverticulum, where the solid fæces become impacted in its lumen.

Gordinier and Sampson[22] report one case of inflammatory changes in a mesenteric cyst of the small intestine, with the presence of many diverticula in the adjoining intestine. But they fail to give microscopic evidence that the cyst was actually developed from a diverticulum.

The analogy between the causative factor in diverticulitis and appendicitis is again close, namely, irritation from fæcal concretion. On the other hand, owing to the motility of the appendix on its mesenteric axis, it is liable to serious damage from circulatory disturbance which is not present in the case of the diverticulum. Consequently, acute gangrenous appendicitis is common, but acute gangrene of a diverticulum as a whole probably never occurs. Another distinguishing difference is that inflammatory changes in the appendix usually involve the mucous membrane to a marked degree, while the mucous membrane lining the diverticulum often escapes until actual perforation is imminent. Wilson discusses this, and would restrict the term "diverticulitis" to those cases in which the mucosa is primarily involved, and use the term "peridiverticulitis" for those cases in which the outer coats of the bowel and surrounding structures are inflamed. The former causes no material reduction of the lumen of the bowel, but tends to perforation into the peritoneal cavity. The latter produces a marked narrowing of the lumen, but owing to the marked reparative process, does not so readily lead to perforation. This distinction of terms seems to us rather superfluous, because the subserosa is quite as much a part of the diverticulum as is the mucosa. Moreover, in many of the cases in which perforation has been reported clinically a condition of "peridiverticulitis"

Digitized by Google

Digitized by Google

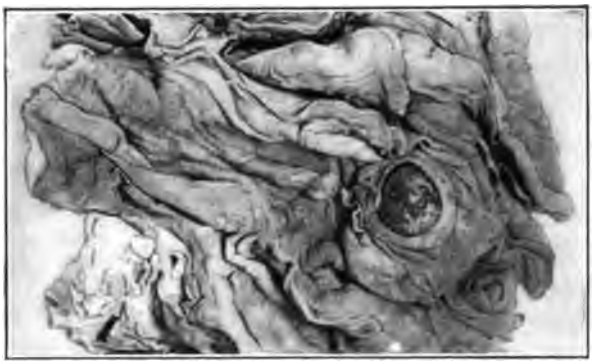


FIG. 5.—Diverticula of the colon. The diverticulum is stuffed with feces. (Case XI.)

Digitized by Google

did exist. It is also important to note that the inflammatory changes in diverticula are most marked in the connective tissue coats of its wall, the submucosa and the subserosa.

For this reason it is probable that the acute perforations result in chronically inflamed diverticula, and that the acute inflammations themselves are usually superadded upon a chronic inflammation. The tendency of a perforation of the diverticulum to communicate with the bladder is worthy of emphasis. Formerly, these communications between the sigmoid and the bladder were attributed mostly to cancer, but Harrison Cripps[23] collected sixty-five cases of vesicocolic fistula, in forty-five of which an inflammatory process was shown to be the underlying cause, as against nine in which cancer was so related.

The clinical manifestations of these conditions are readily understood by a direct application of these pathological changes.

It must again be emphasized that the diverticulum itself, that is, a pouch of the intestinal wall, is not capable of giving symptoms. It is only when added to this, there exist some of the secondary changes above described that the symptoms arise. Autopsy records show the frequent presence of diverticula which, even when packed full of feces during life, have given no hint of their presence (Fig. 5). Moreover, a very considerable degree of inflammation in the diverticulum, and in the immediate vicinity, may be present without giving symptoms. This is well illustrated in one of the clinical cases in this series in which a chronic perforation took place with no accompanying signs until the moment of perforation.

On the other hand, there may be evidences of the secondary changes present during the chronic stage. These are: disturb-

Digitized by Google

ance of the action of the bowels, usually constipation, and possibly a dull aching pain.

These cases may recover spontaneously, according to Mayo,[24] and he reports a case in which recurrent symptoms had been present over a period of years. Here, again, we see an analogy to appendicitis.

There are no symptoms referable to the varying inflammatory conditions that are in any way pathognomonic. The same clinical picture is seen when similar pathological processes are present from other causes. For this reason, rarely, if ever, has a positive pre-operative diagnosis been made, and an error is not infrequent, even on opening the abdomen. However, certain symptoms are significant, and with our increasing knowledge, errors both before and during operation will become more infrequent.

The predilection of the descending colon and sigmoid to be the seat of serious changes in diverticula, leads at once to a tentative diagnosis of this condition when evidence of acute or chronic inflammation exists in the left lower quadrant of the abdomen. (One of our clinical cases, however, was in the ascending colon.) This, occurring in persons in the middle decades of life, is sufficient to suggest a diverticulum as the starting point of the trouble, but it must be emphasized that an increasing number of cases showing inflammatory symptoms are being found in young persons. The symptoms may be those of a local abscess, a more or less general peritonitis, or a partial or complete intestinal obstruction. They may be acute, subacute, or chronic. Owing to the absence of ulcerative changes in the mucous membrane, diarrhœa and blood in the stools are the exception, though the latter existed in the case of Moschcovitz, the specimen from which is included in this series. The usual absence of these symptoms helps to dif-

Digitized by Google

ferentiate the condition from tuberculous inflammations, and, to a certain extent, from syphilitic inflammation and carcinoma.

In those cases in which the inflammatory exudate is extensive, leading, as it may, to a palpable tumor, there are no clinical manifestations which differ from a similar condition due to other causes. The absence of other evidence of tuberculosis or syphilis, and the absence of blood in the stools, all point to the presence of diverticular trouble, but a positive diagnosis cannot be made. The greatest difficulty exists under some circumstances in excluding carcinoma of the sigmoid. The resemblance to this neoplasm is so close that many surgeons have been in error after opening the abdomen, the thickened indurated section of the gut being in every way the same in both processes, and primary resection has been done because of the mistaken diagnosis. Telling, in his pathological classification, gives as one type those mimicking carcinoma, and adds that he believes that many an inflammatory lesion would be found to be present in jars on museum shelves labelled "carcinoma," if their contents were carefully examined.

Moynihan[25] reports five cases in which a resection was done in the erroneous belief that cancer was present. In two of these the lesion was positively demonstrated to be due to diverticular inflammation. In a sixth case the indurated colon and sigmoid were believed to be the result of cancer, and the case was considered inoperable. The subsequent recovery proved the error of this diagnosis, and the case probably should be included as diverticulum disease. An enterovesical fistula, with gas or fecal matter passing out with the urine, points to a diverticulum rather than to cancer. Thus we see that, clinically, we recognize a classification which conforms in every

Digitized by Google

particular with that adopted for the secondary pathological changes.

Beer, Telling, Eisendrath,[26] and others have formulated tables of such classification, which possess merit. However, an understanding of the possible anatomical lesions serves every purpose, and since all these lesions have now been reported clinically, a table of clinical possibilities is nothing more than a repetition.

The treatment for the secondary changes growing out of the presence of diverticula, except the milder grades of chronic inflammation, is purely operative. A laparotomy must be performed, and the actual condition met with must be treated on the general principles of intestinal surgery. In the case of a perforation, it may be dealt with by simple excision of the necrosed area, and suture, or a section of gut may be excised and an anastomosis done. The latter is only needed when the perforation is large, and the adjacent gut wall is so thickened that a proper closure cannot be effected.

A second indication for excision of the gut is the narrowing of the lumen by inflammatory thickening to a point which threatens its patency. But in this connection it must be remembered that much of the inflammatory exudate may be absorbed when the exciting cause, namely, the inflamed diverticulum itself, is removed. On the other hand, we must bear in mind the possibility of more than one diverticulum being present, so that a proper attention to the perforation, or the most apparent pouch, may not remove the causes exciting inflammation. Again, the possibility of the development of cancer as a subsequent change must be given its full weight in deciding against intestinal resection.

The surgical management of the local abscess, the general peritonitis, the adhesive ileus, or the fistulous opening into the

Digitized by Google

bladder is exactly similar to these conditions from other causes and needs no amplifications here.

The following clinical cases and post-mortem specimens illustrate many of the facts included in the foregoing *resumé*. The clinical cases have all been presented before the New York Surgical Society during the session of 1909-1910. So far as we know, none of the other cases have been previously reported.

Case I (Hartwell, Presbyterian Hospital). O. G., male, aged forty-two years, mechanic; was admitted to the Presbyterian Hospital, in the service of Dr. Eliot, to whom I am indebted for the privilege of reporting the case, on April 21, 1909, suffering from an acute abdominal lesion. The family and past history were negative. Two days before admission he developed the typical symptoms of an acute intestinal obstruction, and these had increased continuously until admission. For three or four days prior to the acute symptoms he had noticed that his bowels were constipated—an entirely unusual thing.

Physical examination on admission showed the abdomen uniformly distended and tympanitic. About one inch inside the anterior spine of the ileum, and above it, was felt an elongated mass along the course of the sigmoid, the size of an apple. This mass was tender. Careful questioning failed to get any evidence that the patient had ever been conscious of any abdominal lesion prior to the onset of the acute symptoms. With these, however, the pain was most severe at first at the site of the tumor.

Under gas-and-ether anesthesia a laparotomy was immediately done, the peritoneum being opened over the mass. A walled-off abscess was found lying outside the sigmoid, just above the pelvic brim, which communicated with the lumen of the bowel through a gangrenous looking perforation. For a distance of about two inches the entire bowel wall was markedly thickened, as was the mesentery connected with it. There were two adhesion bands kinking and pressing on the gut in such a way as to cause the obstruction, but it was noted that the colon, as far as could be seen above this point, was not unduly distended. No diagnosis was made as to the pathology of the lesion. Cancer and tuberculosis were thought of as the most probable, though diverticulitis also was mentioned. A primary resection of the diseased portion was done, with an end-to-end suture anastomosis. The abdominal wound was sutured with drainage.

The post-operative course was unsatisfactory, and the symptoms of obstruction increased rather than lessened. After twenty-four hours, therefore, the wound was opened, and as the anastomosis did not look entirely satisfactory, though the lumen was patent, the stitches were removed and a Murphy button inserted. The patient recovered after a rather tedious convalescence, and has remained well up to present time.

Digitized by Google

The specimen removed consists of a piece of sigmoid 7 cm. long (Fig. 6). The peritoneal fat and appendices epiploicæ are abundant. On the external aspect of the section is an indurated mass, irregularly globular, measuring 4 to 6 cm. in diameter. This mass lies within the gut wall and is covered externally with peritoneum and intestinal fat. Through this mass passes a perforation into the intestinal lumen, admitting a surgical probe. The surface of this sinus is ragged and ulcerated. The perforation passes through the posterior part of the mass, and a transverse section through the mass shows the mucous membrane pouching out along the line of the perforation, demonstrating the presence of a diverticulum at this point. There are four other diverticula present, having an average depth of ½ cm.; two of those lying adjacent to the one that has perforated show a lesser amount of induration in their walls. Microscopically,[37] a section taken through the tract of the perforation shows extensive necrosis and acute inflammatory changes involving all the coats of the gut (Fig. 7). At one place the mucosa dips down as if to form a diverticulum, but becomes almost at once unrecognizable in a mass of necrotic tissue. This necrosis involves the muscularis, which is considerably thinned out at this point, as well as the subperitoneal fat tissue. The parts surrounding the necrosis are densely infiltrated with polymorphonuclear leukocytes and lymphoid cells. Sections through two of the adjacent diverticula shows both of them to be true diverticula, being surrounded by normal muscularis of the usual thickness. The subserosa contains many lmphoid cells, with a few polynuclear leukocytes. Both of these diverticula are more or less cylindrical in shape, maintaining about the same diameter throughout their entire length. The deeper one measures 12 cm. in length; the other, 0.7 cm.

Case II (Hartwell). Male, aged twenty-three years. Admitted to the Presbyterian Hospital August 9, 1909, giving a complicated clinical picture, which is reported in full elsewhere.[38] He presented at operation the following condition: The abdomen contained a small amount of fluid, of characteristic serous exudate. The large intestine, from the splenic flexure to the rectum proper, was found to be the seat of a marked uniform thickening, involving its whole circumference. This wall was estimated to be about ⅜ inch in thickness, so that the intestinal tube was rigid and hard, but its lumen was not appreciably narrowed. At the splenic flexure the lesion had, to a certain extent, kinked the bowel, causing a moderate degree of obstruction. The mesentery of the descending colon was thickened quite as much as the bowel itself. The spleen was soft and somewhat enlarged. No other lesions were found in the peritoneal cavity, a thorough examination being made to find tuberculosis, but without avail. The adhesions which were causing the obstruction were loosened, and the whole length of the descending colon was examined for the purpose of finding a perforation or any other cause for the condition at hand. The process gave all the appearances of a simple inflammatory thickening, involving the bowel and its mesentery. It was impossible to erad-

Digitized by Google

FIG. 6.—Part of the sigmoid. On the right is an indurated mass of inflammatory tissue, laid open along the tract of the perforating diverticulum. (Case I.)

FIG. 7.—Microscopic section through a perforating sinus. The section shows the mucosa abruptly terminating in a mass of necrotic tissue. The wall of the gut is thickened and infiltrated with leukocytes. (Case I.)

Digitized by Google

Digitized by Google

icate the disease, consequently the abdomen was closed with drainage. A pathological report on the peritoneal fluid showed it to be sterile.

A microscopical examination of a small piece of the tissue removed from the surface of the bowel showed it to be fat, infiltrated with small round cells, and extravasated blood. There was an increase of fibrous tissue and the walls of the blood vessels were thickened, and the lumen contracted. There was no especial perivascular change, and no evidence of either syphilis or tuberculosis could be found. The diagnosis made by the pathologist was chronic fibrous peritonitis.

The postoperative history was uneventful. There was but little drainage from the wound, and it healed kindly. Since his discharge from the hospital, on September 10, the patient has been attending to his work, and is in very excellent general health. There is still present a mass in the left lower abdomen, which is not materially changed since the operation, but it gives rise to no symptoms whatever. All the evidence at our disposal points to the condition of the colon as being one of a simple inflammatory process involving the coats outside of the mucous membrane. Tuberculosis and syphilis both involve the mucous membrane, and give symptoms of this involvement. Cancer must be ruled out by the extent of the disease, and the subsequent good health of the patient. On the other hand, such inflammatory thickening arises from diverticulitis, as has been amply demonstrated, both by previous writers and by the specimens here presented, and we therefore think that it is proper to include the case as one of probable multiple diverticulitis. In this connection Telling states that he has found the thickening to be more marked in those diverticula with small openings, and narrow channels. Such diverticula cannot be demonstrated from the external surface of the thickened bowel.

Case I showed the same condition in a local area, but here a perforation was also present. These are the cases that give the mimicry of cancer.

Case III (Hartwell). A. G., female, aged forty-three years. Admitted to the Presbyterian Hospital, August 30, 1909. For ten years she had suffered from recurring attacks of abdominal pain, coming on at night and being relieved by vomiting. The pain was general, but was most severe in the epigastrium. Two years prior to admission into the hospital the pain began to localize itself in the right lower quadrant of the abdomen. With the attacks there was fever. They recurred every three or four months, and lasted about one week. She habitually suffered from constipation. There was never any knowledge of blood in the stools. The physical examination showed no abnormalities except some evidence of a chronic pelvic peritonitis, and a mass in the right lower quadrant of the abdomen. This was about the size of a billiard ball, of stony hardness, and fairly smooth surface. It was tender to pressure. It occupied the middle outer part of the quadrant, and was firmly adherent to the posterior abdominal parietes.

Operation was performed on September 12. On opening the peritoneum the mass was found to lie just outside the cecum, and to consist of the appendix, the cecal wall, and adventitious tissue. The appendix was much thick-

Digitized by Google

ened, but not acutely inflamed. It lay with the tip pointing upward, outside of the cecum, buried in hard tissue. On dissecting it free, the tip was found to be closely adherent to the colon, just anterior to the outer mesenteric leaf, where it closed a necrotic opening 0.5 cm. in diameter in the much thickened and hard wall of the colon. This opening admitted a probe into the lumen of the bowel. The appendix was removed. The tissue for some distance around the sinus was cut away in two pieces, and the opening thus made closed with three layers of sutures. The lumen of the colon and cecum contained old, partially digested blood clots, the origin of which could not be determined.

The post-operative course was uneventful, and the patient remains well at the present time.

The specimen consists of: (1) Two pieces of intestinal wall (cecum), both of which show considerable thickening. In one of the pieces there is a small saccule, 8 mm. in diameter and 9 mm. in depth, lined with mucous membrane, which appears to have pushed through the muscularis. (2) An appendix, 4 cm. in length; serosa of distal portion covered with fibrin; no perforation; mucosa smooth. Microscopically: (1) Sections taken through the diverticulum show a small sac lined with intestinal mucosa, which is thrown up into small folds. At one point the mucosa is necrotic. The lumen of the sac contains pus. The wall of the sac is composed of fibrous tissue, apparently thickened serosa, infiltrated with polymorphonuclear leukocytes and lymphoid cells, but free from necrosis. No muscular tissue remains in the wall. Its blunt point of termination on either side of the sac is sharply defined (Fig. 8). The terminal muscle fibers show signs of atrophy and are being replaced by fibrous tissue. (2) Sections through the cecum adjacent to the diverticulum show considerable thickening of the muscularis and serosa, and a universal infiltration by polymorphnuclear leukocytes, lymphoid and plasma cells in all the coats. There is a formation of fresh granulation tissue on the serosa. (3) Appendix. The mucosa is intact. The muscularis and serosa contain a moderate number of lymphoid cells. The serosa is thickened. Our interpretation of this case is that the cecum contained a number of diverticula. One of these had perforated and sloughed away. A second one, acutely inflamed, is the one from which the above described section was taken.

Case IV (Moschcowitz). Female, aged thirty-seven years. This patient had suffered from a number of conditions requiring surgical attention in earlier life. Among these was an acute appendicitis, for which she was operated on in 1904, and gastric ulcer, which was cured without operation. In 1905 she first began to suffer from intestinal trouble, which manifested itself by diarrhoea, tenesmus, and blood in the stools. Examination then showed a tender sausage-shaped mass in the left iliac fossa. In June, 1906, she was operated on, and a condition of retraction and contraction of the mesosigmoid, with many scar-like adhesions taking their origin from multiple diverticula of the sigmoid, was found. Separation of the adhesions, and straightening out of the intestinal coils gave relief for about two years, when the symptoms recurred. In March, 1909, a resection of the diseased portion of the sigmoid

Digitized by Google

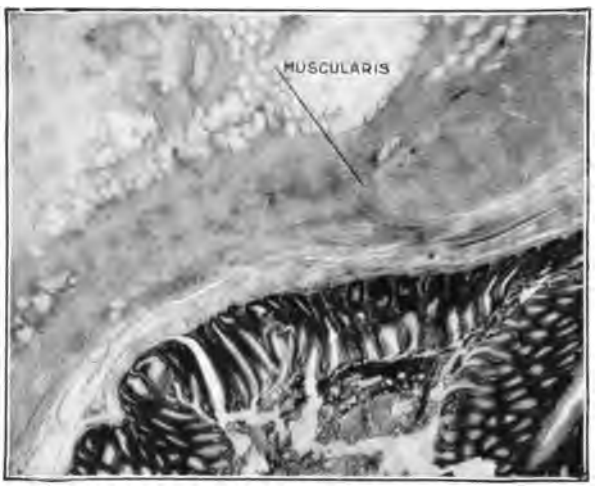


FIG. 8.—Microscopic section through a diverticulum. (Only half of the diverticulum is shown). The muscularis ends abruptly at the neck of the sac. The wall of sac is composed of mucosa and serosa. The latter is infiltrated with leucocytes. (Case III.)

Digitized by Google

Digitized by Google

was done, and this has resulted in a complete cure up to the present time. The specimen consists of a section of the sigmoid, 12 cm. in length, hardened in formalin. After opening along the anterior border, inspection from the inside shows fourteen diverticula. These are all small, having a communication with the intestine, 0.5 cm. in diameter, and a depth of 0.5 cm. None showed marked evidence of inflammation. In the hardened specimen there is no evidence of their presence on the peritoneal surface of the gut. The whole intestinal wall, however, seems somewhat thickened. Microscopically, a longitudinal section through one of the diverticula shows the following: The mucosa lining the saccule is normal. The submucosa shows no changes. The circular coat of the muscularis is very much thinned over the fundus of the sac. The longitudinal layer maintains its normal thickness. The submucosa contains considerable fat tissue. In the region of the diverticulum it is infiltrated with a moderate number of polymorphonuclear leukocytes and lymphoid cells. The serosa is thickened. The intestine adjacent to the diverticulum is normal.

CASE V. The patient from whom this specimen was obtained was a male, aged forty-eight years. He died in the Bellevue Hospital from general metastases, following an epithelioma of the œsophagus. Nothing in the history gave any indication of a lesion existing in the sigmoid. There was no evidence of any cardiac trouble nor any condition leading to portal congestion.

The specmen consists of the lower end of the sigmoid, measuring 12 cm. in length, and containing six diverticula, all of which have a long, narrow neck, barely admitting a small probe, through which they connect with the lumen of the intestine. The diverticula are spherical in shape, and measure about 0.5 cm. in diameter. They are filled with semisolid feces. This feces, owing to the narrowness of the outlet, are practically prevented from reentrance into the lumen of the bowel. The position of the diverticula is on either side, between the anterior and lateral teniæ. In some cases the diverticulum is in close relation to an appendix epiploica. In others, no such relation can be demonstrated. The thickness of the intestinal wall is distinctly greater in that portion where the diverticula are present than in that portion where they do not exist.

Microscopically, sections taken transversely through two different diverticula present the same picture. The mucosa is thick at the neck, but becomes thinned out in the fundus. The muscularis of the adjacent gut is hypertrophied, but only a small part of the longitudinal layer passes about the diverticula, forming a thin strip of atrophied muscle between the mucosa and serosa. By the use of Van Gieson's stain, considerable fibrous tissue is found between the muscle fibrillæ about the diverticulum. The subserosa contains several fairly large blood vessels, both arteries and veins, and a considerable quantity of adipose tissue. The serosa appears normal. There is no sign of acute or chronic inflammation in any part of the saccule.

CASE VI. The specimen was removed from a male, aged seventy-five years, who died in the Presbyterian Hospital following a resection of the

Digitized by Google

small intestine for gangrene in a strangulated hernia. The autopsy showed a general arterial sclerosis and a chronic endocarditis, but there was no evidence of congestion in the abdominal viscera. The specimen consists of a small section of the transverse colon, which presents one diverticulum. This arises from a plane midway between the anterior and one of the lateral tenia. It is exactly globular in shape, and measures 1 cm. in diameter. It communicates with the lumen of the gut by a circular opening, also 1 cm. in diameter. The sac of the diverticulum contains an elliptical enterolith about 0.5 cm. in its long axis and 0.25 cm. in its short axis. This, therefore, lies loose, and is not impacted. The walls of the diverticulum are distinctly thinner than the wall of the gut around it. This specimen was preserved intact, so that no microscopic sections were taken.

Case VII. The specimen was obtained from a boy, aged six years, who died in coma in the Presbyterian Hospital from an acute infectious condition of only twenty-two hours' duration. The only abnormalities found at autopsy by the coroner were those described below, under the specimen, and a condition of ulceration in other parts of the colon and lower ileum.

The specimen consists of a piece of colon showing three haustra. Each of these is more sacculated than normal. The specimen is opened along the mesenteric line. In one of the haustra the walls are distinctly thinner than in the others, and here exist two diverticular pouches, one on either side of the anterior tenia (Fig. 3). They are exactly similar, being globular in shape, and measuring about 2 cm. in diameter. Their communication with the lumen of the gut is by a circular opening of the same diameter. The condition, therefore, is more a giving way of the whole wall of the gut in an intermuscular portion than the presence of actual diverticula. The thickness of the wall in this weakened haustra is much less than in those adjoining it.

Microscopically, a section through the diverticulum, taken longitudinally, shows a small saccule lined with flattened mucosa, but completely surrounded by a muscularis, which consists of both the circular and longitudinal layers. Both layers are considerably thinner here than in the adjacent intestine, but in all other respects they appear normal. The serosa and subserosa are normal. The intestine adjacent to the diverticulum is normal.

Case VIII. This specimen was obtained from a female, aged ten years, who died in the Presbyterian Hospital from a septic meningitis following otitis media. There was nothing in the history pointing to any intestinal trouble. At the autopsy nothing was found indicating any interference with the venous circulation of the abdominal viscera.

The specimen consists of a small piece of the sigmoid, which has been opened along the mesenteric line. There is one diverticulum present. Its communication with the intestine is oval, measuring 1 cm. in length and 0.5 cm. in width, the longer diameter being transverse to the axis of the gut. The pouch is about 0.5 cm. deep, and is of the same diameter as the opening into the intestine. There is no appreciable difference in the thickness of the wall of the diverticulum and that of the intestine about it. The position of

Digitized by Google

the diverticulum is midway between one of the lateral tenia and the mesenteric line.

No relation to an appendix epiploica can be made out.

Microscopically, transverse sections through the diverticulum show the following changes: The mucosa lining the saccule is flattened. The submucosa is normal. The muscularis becomes rapidly thinner as it passes on to the diverticulum, but does not disappear entirely (Fig. 4). Over the fundus it has been largely replaced by fibrous tissue, and it is only in sections stained by Van Gieson's method that the atrophied muscular fibers, chiefly of the longitudinal coat, can be recognized. The serosa and subserosa are normal. There are no large vessels in the wall of the sac. The intestine adjacent to the sac is normal.

CASE IX. This specimen was obtained at the autopsy in a female, aged sixty-five years, who died in the Presbyterian Hospital from chronic obstructive jaundice due to the calculus, gangrene of the gall-bladder, and septic cholangitis. The heart was dilated, but there was no evidence of any disturbance of the circulation in the intestinal veins.

The specimen consists of a piece of the descending colon and sigmoid, measuring 60 cm. in length. In its lower half are counted fourteen diverticula, many of which are filled with fecal concretions. The average diameter of the opening into a diverticulum is 0.5 cm. The average length is 1 cm., and the fundus of the sac is usually about twice the diameter of the neck. Each diverticulum has its os lying in a plane midway between a lateral tenia and the mesenteric line, and the sac extends outward into an appendix epiploica. There is no gross evidence of any inflammatory thickening about the diverticula or in the intestinal wall adjacent to them. On the contrary, in those diverticula which are distended with feces, the fundus of the sac seems distinctly thinner than the rest of the gut wall.

Microscopically, transverse and longitudinal sections through the diverticula shows no inflammatory changes. The mucosa is slightly flattened. The circular layer of muscularis becomes greatly thinned at the neck of the diverticulum, and soon disappears. A slender band of longitudinal fibers, containing considerable fibrous tissue, completely encircles the sac. The transverse section shows a large artery and vein in the subserosa of the fundus. The serosa is normal.

CASE X. This specimen was obtained at the autopsy of a male, aged fifty-six years, who died in the Bellevue Hospital of acute lobar pneumonia. The clinical history gave no evidence of any intestinal lesion. Neither the clinical history nor the autopsy gave evidence that any chronic disturbance in the intestinal venous circulation had been present.

The specimen consists of a portion of the ileum. At one point opposite the mesenteric attachment there is a Meckel's diverticulum, measuring 9 cm. in length and 3 cm. in diameter throughout its length. On this diverticulum are distinctly seen four secondary diverticula, each about 1 cm. in diameter and 0.5 cm. in depth. There is a slight constriction near the middle of the

Digitized by Google

large diverticulum, corresponding to the line of the obliterated vessel coming from the mesenteric border. On opening the intestine this pouch communicates with the lumen of the gut by a circular opening 2 cm. in diameter. The secondary diverticula can be seen opening into the large pouch.

CASE XI. A male, aged sixty-six years, died in the Bellevue Hospital from general arterial sclerosis and cardiovascular disease. General anasarca was present and there was very severe congestion of all the abdominal viscera.

The specimen consists of the cecum and a portion of colon measuring 12 cm. in length. Five diverticula are present, varying from 0.25 cm. to 2 cm. in diameter. The larger ones are filled with hard, fecal masses (Fig. 5). The communication with the lumen of the gut is always smaller than the pouch of the diverticulum, but there is no neck. The expanded pouch around the mouth of the sac is thinned, and the wall of the pouch itself is distinctly thinner than the surrounding intestinal wall. The diverticula lie in planes between the mesenteric line and the lateral tenia on either side. One diverticulum is in the cecal pouch itself, and on the external surface lies 2 cm. external to the origin of the appendix vermiformis.

Microscopically, a section taken transversely through one of the diverticula shows the following: The sac is connected with the lumen of the intestine by a very small opening. The mucosa is reflected over the margin of this opening and lines the entire sac. The portion in the sac, however, is thinner than that lining the adjacent gut and is covered with a layer of structureless material. The submucosa is normal. The circular layer of the muscularis surrounds the sac, but shows a marked thinning, and more or less replacement with fibrous tissue. The longitudinal fibers are not found in the wall of the sac. A large artery and vein lie in the subserosa of the fundus of the sac. The serosa and subserosa are normal. The intestine adjacent to the diverculum is normal.

CASE XII. The specimen was obtained from a male patient, aged sixty-eight years, who died in the Presbyterian Hospital from carcinoma of the prostate, bladder, and liver, the primary lesion being in the liver. There was no evidence at autopsy of any interference with the circulation in the intestinal veins.

The specimen consists of the whole large intestine. In the cecum there are three diverticula measuring 8 to 9 mm. in diameter. Surrounding them is a distinct area of inflammation. The transverse colon and sigmoid show an increasing number of diverticula, all small in size. The diverticula are distributed irregularly and show no definite relation to the mesentery or tenia. These diverticula vary in diameter from a few mm. to 1 cm. The entrance to the diverticulum is always much smaller than the lumen of the pouch itself. The wall of the descending colon and the sigmoid is much thickened by tissue in the middle layers of the wall. At one point this thickening is extreme, the wall measuring nearly 2 cm. in thickness. In this situation the diverticula are very numerous, being closely packed together. Microscopically, a section taken transversely through two adjacent diverticula in the sigmoid shows the

Digitized by Google

following changes: The mucosa in both sacs is intact but infiltrated with a large number of small, round cells of the lymphoid type. The submucosa shows a similar infiltration. Over the fundus of one saccule the submucosa is necrotic and contains several large vacuoles which suggest that the tissue has contained gas. As there are no polynuclear leukocytes about this area, it is probable that the change is a postmortem one. The circular layer of muscularis has undergone considerable hypertrophy, a change which can be observed not only in the wall of the intestine between the diverticula, but in the lateral walls of the diverticula themselves. Over the fundi, however, the muscularis becomes thin. The longitudinal layer of the muscularis is not made out. At many points the muscularis of the sac wall is densely infiltrated with lymphoid cells. Large vessels occur in the subserosa of both saccules. The subserosa contains a good deal of adipose tissue and many lymphoid cells. The serosa is normal. Another section taken through one of the diverticula in the ascending colon shows no inflammatory changes, and no hypertrophy of the muscularis. A thin strip of the circular layer of muscularis surrounds the saccule.

CASE XIII. The specimen (Museum specimen, Bellevue Hospital) consists of a portion of small intestine, 30 cm. in length. Seven small oval diverticula, varying in size from 0.5 to 1.5 cm. in diameter, occur along the mesenteric border between the folds of the mesentery, but bulging more on one side than on the other. In each case a vein may be seen traveling from the convex border of the intestine in the subserosa, and passing directly over the diverticulum to reach the mesentery. This vein is always present only on the side toward which the diverticulum bulges. The leaves of the mesentery can be stripped off the diverticula.

On opening the gut, the communication between its lumen and the diverticulum is seen in each case to be smaller than the diameter of the diverticulum itself. Three additional openings are found communicating with diverticula too small to be identified from the external surface. The opening to the diverticulum is situated, in most cases, on one side of the mesenteric line. A few seem to correspond exactly to its line of attachment. The same relation of the diverticulum to the vein is manifest, and it is the course of this vein toward the mesentery that determines the direction of the growth of the diverticulum.

Microscopically, sections have been taken transversely through the gut at the site of one of the small diverticula. The mucosa and submucosa are everywhere normal. The muscularis extends down for some distance over the saccule, but is absent over the fundus. The longitudinal layer extends further down than the circular. It becomes gradually thinner and finally disappears. The serosa and subserosa are not thickened. There are no large vessels in the wall of the saccule. The intestine adjacent to the diverticulum is normal.

CASE XIV. The specimen (museum specimen, Bellevue Hospital) consists of a piece of small intestine 40 cm. in length, showing thirteen diverticula, varying in diameter from 0.25 cm. to 6 cm.; eleven of these are crowded to-

Digitized by Google

gether into a piece of intestine only 22 cm. long, so that there is practically no part of the mesenteric border free from a diverticulum. The same relationship between the diverticula and the mesentery and veins is present as described in Case XIII. The walls of the larger diverticula are somewhat thicker than those of the smaller ones. There is no communication between the individual diverticula even where they are close together.

Microscopically, a section taken longitudinally through the gut displays a portion of diverticulum of rather large size. The mucosa is flattened. The submucosa is normal. The two coats of the muscularis extend down over the saccule, but become much thinner at the neck. The circular layer becomes rapidly thinner and soon entirely disappears. The longitudinal layer appears to continue as a thin strip clear around the sac. The serosa and subserosa are normal.

Case XV. The specimen (museum specimen, Bellevue Medical College) consists of several small pieces of colon showing diverticula packed rather closely together and varying in size from 1 cm. to 3 cm. in diameter (Fig. 9). They show the same general characteristics as the other specimens, but owing to the way in which the specimen has been mounted, the relation of the diverticula to the mesentery and vessels cannot be determined.

Microscopically, sections taken transversely through a small diverticulum show considerable post-mortem change, but the different coats can still be made out. The mucosa and submucosa are normal. The muscularis, both the circular and longitudinal, extends up for some distance on either side of the neck, but becomes progressively thinner and soon disappears. Occasional bundles of the longitudinal fibers occur over the fundus. The serosa and subserosa are normal. No large vessels are found in the subserosa.

Case XVI. The specimen (museum specimen, Presbyterian Hospital) consists of the duodenum, which shows the presence of eight small diverticula, the largest measuring 1.5 cm. in diameter, all of which occur in close relation to the mesenteric attachment. All but one are situated in the portion of duodenum distal to the papilla of Vater. The general appearance and gross structure is the same as that described for those in other parts of the small intestine.

Microscopically, the diverticula were studied in transverse and longitudinal sections. The walls of the saccules are composed of normal mucosa and considerably thickened serosa. Both the transverse and longitudinal portions of the muscularis come to a rather abrupt ending at either side of the neck of the sac. There is a large artery in the subserosa of one of the saccules. The intestine adjacent to the diverticula shows no change.

Case XVII. The specimen (museum specimen, Bellevue Medical College) consists of a section of colon 10 cm. in length. On the two lateral aspects of the intestine are closely crowded together fusiform diverticula, from 1 cm. to 1.5 cm. in length and 0.75 in diameter (Fig. 4). The bases of the diverticula lie in two lines directly posterior to either lateral tenia. There

Digitized by Google

FIG. 9.—Diverticula of the colon, showing the openings of the diverticula into the gut. (Case XV.)

Digitized by Google

FIG. 10.—Microscopic section through a diverticulum. The muscularis terminates suddenly at the neck of the sac. The mucosa and serosa are greatly thinned. (Case XVII.)

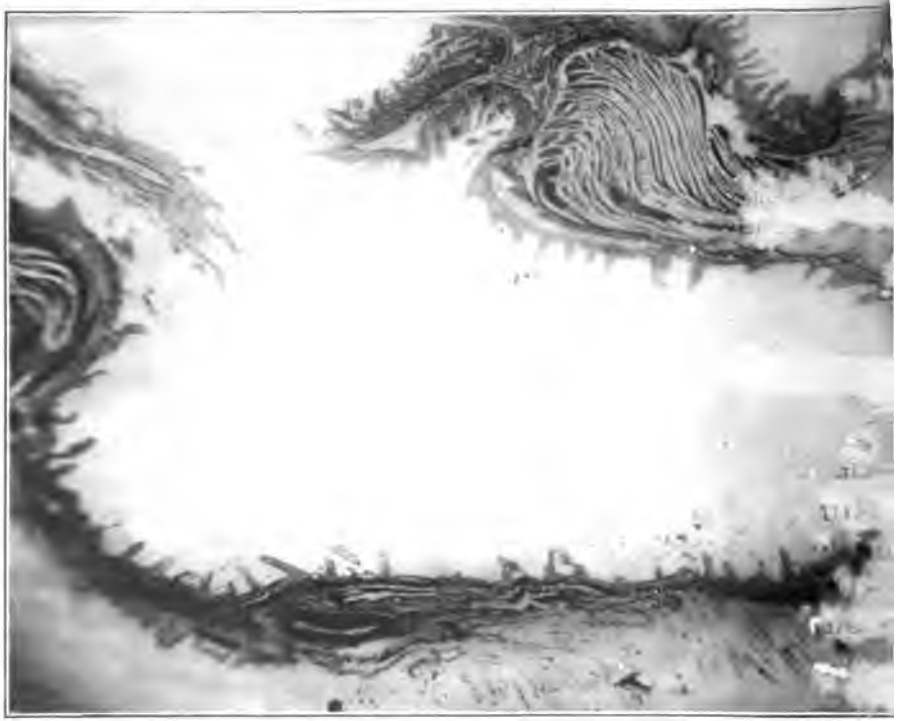


FIG. 11.—Microscopic section through a diverticulum, showing the artery a in the wall of the sac. (Case XVIII.)

Digitized by Google

is a distinct interval of normal intestinal wall lying between the mesenteric attachment and the diverticula on either side.

On opening the intestine, each diverticulum is seen to communicate with the lumen by an opening somewhat smaller than the diverticulum itself. This inequality, however, is not nearly so marked as in some of the other specimens. In two instances, two diverticula communicate with the intestine by a common opening, the septum which originally separated them having in part disappeared. In each of these cases the two individual diverticula lie in an oblique, nearly transverse plane.

Microscopically, transverse and longitudinal sections through the diverticula present similar pictures. At one point the wall of the gut is greatly thinned out, and takes the form of a small saccule. The muscularis terminates suddenly on either side of the diverticulum, so that the wall of that structure is composed only of mucosa and serosa (Fig. 10). The former is very thin, and atrophic looking, the crypts having largely disappeared. The serosa is also quite thin. The intestine adjacent to the diverticula exhibits no changes. In neither the transverse nor the longitudinal sections can any large vessels be found.

CASE XVIII. The specimen (museum specimen, Presbyterian Hospital) consists of a piece of small intestine, measuring 135 cm. in length. Thirty-three diverticula are present. They are all in close relation to the mesenteric border in their origin and pouch on either side beneath the mesenteric leaf (Fig. 1).

In nearly every case a large vein, and sometimes an artery, may be seen [illegible] over the pouch of the diverticulum. The intestine has been preserved unopened, so that no description of the diverticula from the inside is given. They measure from 0.25 cm. to 6 cm. in diameter, all being of a globular shape.

[illegible]ally, a transverse section through one of the diverticula shows [illegible] opening into the gut through a narrow opening. The wall of the sac is composed chiefly of the inner and outer coats of the gut, the longitudinal fibers of the muscularis extending down for only a short distance on either side as a thin strip. The mucosa and submucosa shows no changes. The cross-sections of two large vessels—a vein and an artery—occur in the [illegible]dur (Fig. 11). The serosa shows no perceptible thickening. [illegible] section through another diverticulum presents a very similar appearance. The muscularis, however, in this case, stops abruptly on either side of the neck of the saccule. A large vein is found in the subserosa. The [illegible]e adjacent to the diverticulum in both cases appears normal.

SUMMARY OF REPORTED CASES. Four patients showed symptoms for which they underwent operation. Of these, three suffered from chronic symptoms, and were cured by operation; [illegible]ffered from acute obstruction, and was cured by opera-

Digitized by Google

tion. Eight specimens were obtained from autopsies on persons dead from causes not connected with the diverticula, and in none of them had any symptoms relative to this condition ever been present. The remaining six specimens were found in the museums, and no clinical or postmortem data were obtainable.

Sex. Of thirteen cases in which the sex is given, ten were female and three were male.

Age. The two youngest cases were six and seven years old, respectively. Three were under thirty years of age, and six were over fifty. The ages of those giving clinical symptoms were between twenty-two and forty-three, thus demonstrating that neither the diverticulum nor its inflammation is solely a disease of advanced life.

The number of diverticula in each case was as follows: The least was one and the most was thirty-three, with an average of about ten. Location: Of the eighteen cases, seven involved the descending colon, or the sigmoid, or both; three involved the ascending colon; one involved the cecum; two involved the transverse colon; two involved the "colon," the particular portion not being given; four involved the small intestine, one of which was in the duodenum; one involved the wall of a Meckel's diverticulum. In five out of the eighteen cases, the diverticula occurred in the small intestine. In all but one of these the diverticula were in close relation with the mesenteric line. None of those in the large intestine was so placed, the greatest number, eight cases, being found between a lateral tenia and the mesentery. Only one was found in the convex border of the intestine. In three of the five cases occurring in the small gut, there appeared to be a definite relationship between the diverticula and the mesenteric veins. No such connection could be established in any of the cases occurring in

Digitized by Google

the large gut. In only one was there any evidence that a venous congestion in the inferior mesenteric veins had been present during life, while in eleven this was absent. This is in direct opposition to the findings of Graser. In the remaining six no information on this point was obtainable.

Of the fifteen cases from which microscopic sections were cut, twelve showed more or less muscularis about the particular sac studied. In the other three cases, the fundus of the sac was composed of only the inner and outer coats of the gut, the muscularis terminating abruptly at the neck of the sac. In five of the twelve cases in which a muscularis was demonstrated, both muscular layers were present. In five others, only the longitudinal coat survived. In the remaining two cases, only the circular coat could be demonstrated. By means of the Van Gieson's stain, traces of atrophied muscularis were found in several instances in which it had been overlooked in hematoxylin-eosin preparations. As a rule, we have found that the larger the diverticulum, the thinner and more atrophied is the muscularis. The circular layer is generally the first to disappear.

CONCLUSIONS. 1. Diverticulum of the intestine is a common condition.

2. The large bowel is the most frequent site, particularly the descending colon and the sigmoid.

3. Children and young adults are subject to diverticula, and to the secondary changes occurring in them.

4. All diverticula are probably true in their incipiency. The false characteristics are the results of their growth.

5. An inherent weakness existing in the muscularis is probably an important factor in the etiology of diverticula. In the

Digitized by Google

small intestine this weakness appears to exist along the mesenteric attachment.

6. Diverticula undergo the same pathological changes as the appendix vermiformis, and give rise to much the same general symptoms. These pathological changes are not uncommon.

We wish to express our thanks to Dr. Opie for the material from the museum of the Presbyterian Hospital; to Dr. Norris and Dr. Pappenheimer, for specimens from the Bellevue Hospital Laboratory; to Dr. Crowel, for specimens from the museum of the University and Bellevue Medical School; and to Dr. Moschowitz, for permission to include his interesting case in our series. We are also indebted to Drs. Leaming, Jachs, Agnew, and G. M. Smith, for photographs of the specimens.

REFERENCES.

[1] Centralbl: f. Chir., 1898, XXV, Beil. 140; Verhandl. d. deutsch. Gesellsch. f. Chir., 1899, II, 480; Verhandl. d. deutsch, path. Gesellsch., 1900, II, 254; Münch. med. Woch., 1899, XLVI, 721; Langenbeck's Archiv, 1899, LIX, 638.

[2] Jour. Exper. Med., 1900-01, V, 333.

[3] Langenbeck's Archiv, 1900, LXI, 708.

[4] Diss., Lyon, 1907.

[5] Personal communication.

[6] Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1902, IX, 743.

[7] Med. Jahrbücher, 1878, 419.

[8] Deutsch. Arch. f. klin. Med., 1902, LXXIV, 122.

[9] Beitr. z. klin. Chir., 1889, V, 690.

[10] Inaug. Diss., Zurich, 1894.

[11] Virchow's Archiv f. path. Anat., 1896, CXLIV, 400.

[12] Beiträge z. klin. Chir., 1899, XXV, 539.

[13] Langenbeck's Arch., 1903, LXX, 679.

[14] Amer. Jour. Med. Sci., 1904, CXXVIII, 135.

[15] Ann. of Surgery, 1908, XLVII, 300.

[16] Lancet, 1908, I, 843.

[17] Virchow's Arch. f. path. Anat., 1894, CXXXVIII, 347.

[18] New York Medical Record, 1870, IV, 497.

[19] Ame. Jour. Med. Sci., 1909, CXXXVIII, 661.

[20] Verhandl. d. deutsch. Gesellsch. f. Chir., 1902, 402.

Digitized by Google

[22] Trans. Amer. Surg. Assoc., 1907, XXV, 237.

[23] Jour. Amer. Med. Assoc., 1906, I, 1585.

[24] Disser., London, 1888.

[25] Surg. Gyn. Obstet., 1907, V, 8.

[26] Brit. Med. Jour., 1907, II, 1381.

[27] Arch. of Diag., 1909, II, 368.

[28] In the microscopic study of the diverticula, the following technique was used: The sections were cut either longitudinally—that is, parallel to the long axis of the intestine—or transverse to this axis, or both. All sections thus include normal intestine adjacent to the diverticulum and the structures occurring in the neck and fundus of the sac. The sections were stained with hematoxylin and eosin. In addition, duplicates of each section were stained by the Van Gieson method. In every instance, small diverticula, never over 1.5 cm. in diameter, have been used for the microscopical sections.

[29] Proc. New York Surgical Society, Annals of Surgery, April, 1910.

Digitized by Google

Digitized by Google

XX.

PARATYPHOID CHOLECYSTITIS.*

RUSSELL L. CECIL, M.D., ASSISTANT VISITING PHYSICIAN.

The striking similarity which exists between typhoid and paratyphoid fever holds true not only for their mode of onset and clinical manifestations, but also as regards the character of complications encountered. Secondary paratyphoid infections of the bone, joint, testicle, middle ear and bladder have all been reported; while, according to Lorrain Smith,[1] intestinal hemorrhages occur in 5 per cent. of all cases.

The frequency of typhoid cholecystitis would, therefore, warrant the expectation of often meeting gall-bladder disease in paratyphoid fever. While this expectation may be warranted, I have been able to collect from the literature only six authentic cases of paratyphoid cholecystitis. Lorey[2] reported a case of paratyphoid cholecystitis, Type B, in 1908, and asserted that he could find in the literature no other cases of that type which were entirely free from objections.

In looking over the records of cultures taken from the last fifty-two cases of gall-gladder operation in the Presbyterian Hospital, I find that I isolated the colon bacillus sixteen times, the streptococcus seven times, *Bacillus pyocyaneus* and the paratyphoid bacillus once each. In the remainder of the cases the cultures were sterile.

Schottmüller[3] was the first to divide paratyphoid bacilli into two groups. This classification was based on definite cul-

*(*Reprinted from the Archives of Internal Medicine, May*, 1910.)

Digitized by Google

tural and biological differences and has received abundant confirmation. Brion and Kayser[4] designated the groups as Type A and Type B, the former turning milk slightly acid, the latter producing a faint alkalinity; and each developing specific immune bodies. Infections with the Type A paratyphoid bacillus are rare, particularly in Germany. In America this type of paratyphoid fever occurs more frequently. Proescher and Roddy[5] have recently reported forty-eight cases of Type A infections from the Allegheny General Hospital.

The case of paratyphoid cholecystitis which I am about to report falls within the Type A group, and is especially interesting in that the patient gave no history of a previous attack of typhoid or paratyphoid fever. I am indebted to Dr. Eliot for permission to use the clinical history.

Patient.—L. C., female, aged 25, married, admitted November 23, 1908, to the first surgical division of the Presbyterian Hospital, complaining of abdominal pain, nausea and vomiting. Family history negative. Personal history negative. Measles in childhood. No other acute illness. No history of typhoid or paratyphoid fever.

Present History.—Two years ago patient was suddenly taken with severe colicky pains in the gall-bladder region. Attack was accompanied with vomiting, fever and slight jaundice. About one year later, patient had another attack similar to the first. Since then she has been subject to frequent attacks. For the last three weeks she has been constantly ill. Pain is very severe, and radiates to back. Nausea, headache and fever are constant.

Physical Examination.—Patient is fairly well nourished, but looks ill. Chest negative. Abdomen is soft except in the upper right quadrant, where there is some resistance. In the region of the gall-bladder there is a pear-shaped mass, moving with respiration, and slightly tender. Temperature, 101.5; leucocytes, 12,600. Urine shows bile. Clinical diagnosis, cholelithiasis.

Operation.—On November 25 a cholecystectomy was performed by Dr. Eliot. At the operation the omentum was found firmly adherent to the gall-bladder. Wall of gall-bladder was thickened; mucosa was swollen. Gall-bladder contained greenish semiviscid bile, and numberless small stones. The bile-ducts were patent. An abscess containing two ounces of pus was found near the foramen of Winslow. Microscopically, the mucous membrane of the gall-bladder was partially absent, and the other coats were densely infiltrated with polymorphonuclear leucocytes and lymphoid cells.

Digitized by Google

Bacteriologic Examination.—Smears from the gall-bladder mucosa show many polymorphonuclear leucocytes and small gram-negative bacilli. Plate-cultures from the bile, and also from the interior of one of the stones, give a pure growth of an actively motile, gram-negative bacillus. On agar, this organism forms small grayish-white translucent colonies. Litmus milk is acidified, but there is no coagulation after two weeks' growth. Neither blood-serum nor gelatin are liquefied. In Dunham's peptone solution no indol is produced. Broth becomes turbid, but no pellicle is formed. Glucose broth, 1 per cent., is fermented, with the production of a small amount of gas. Saccharose broth is free from gas. In lactose broth there is no gas. In mannite broth there is a small bubble after forty-eight hours. One cubic centimeter of the twenty-four-hour broth culture, when injected intraperitoneally, killed a guinea-pig in less than twenty-four hours. Agglutination tests with the patient's own serum were carried out with a number of organisms. Table 1 shows the results obtained with the various dilutions:

TABLE 1.—AGGLUTINATION TESTS, PATIENT'S SERUM AGAINST VARIOUS ORGANISMS.*

Organism.	1-10	1-20	1-50	1-100	1-200	1-500	1-1000	1-2000	1-5000
Bacillus from patient....	+	+	+	+	+	—	—	—	—
B. paratyphosus, Schott-müller A.	+	+	+	+	+	—	—	—	—
B. paratyphosus, Schott-müller B.	+	—	—	—	—	—	—	—	—
B. typhosus	—	—	—	—	—	—	—	—	—
B. coli communis	—	—	—	—	—	—	—	—	—

*Reading for the three lowest dilutions taken at end of one-half hour; for high dilutions, two hours.

The typhoid bacillus was not agglutinated, even by high concentrations of the patient's serum. The colon bacillus was not agglutinated. The patient's own organism was agglutinated up to a dilution of 1/200. Two other strains of paratyphoid bacillus Type A, were agglutinated at a dilution of 1/100, both microscopically and macroscopically. Two strains of *Bacillus paratyphosus*, Type B, showed some clumping at dilutions of 1-10 and 1-20, but many of the organisms retained their motility. With higher dilutions the reaction was entirely negative. On January 2, 1910, c.c. of a twenty-four-hour culture of dead bacilli from the patient was injected subcutaneously into a male rabbit. On January 7 it received 0.5 c.c. of a living culture, and increasing doses every five days thereafter. The last two doses were given intravenously. At first the rabbit lost weight, but later he regained a considerable part of it. On February 5, 1910, after having received seven injections, the rabbit's serum was tested for agglutinins. Table 2 shows the results obtained.

Digitized by Google

TABLE 2.—AGGLUTINATION TESTS WITH RABBIT'S SERUM.*

	1-10	1-20	1-50	1-100	1-200	1-500	1-1000	1-2000	1-5000	1-10000	1-20000
Bacillus from patient...	+	+	+	+	+	+	+	+	+	+	—
B. paratyphosus, Schottmüller A.	+	+	+	+	+	+	+	+	+	+	+ —
B. paratyphosus, Schottmüller B.	+ —	+ —	—	—	—	—	—	—	—	—	—
B. typhosus	+	+	+ —	—	—	—	—	—	—	—	—
B. coli communis.....	—	—	—	—	—	—	—	—	—	—	—

*Readings for the three lowest dilutions taken at the end of one-half hour; for remaining dilutions, two hours.

The patient's own organism was agglutinated by a 1-5000 dilution of the rabbit's serum, while a stock strain of the paratyphoid bacillus, Type A, was agglutinated by a 1-10000 dilution of the same serum. Neither the patient's serum nor the rabbit's serum had any effect on the paratyphoid bacillus, Type B, the typhoid bacillus, or the *Bacillus coli communis*, except in very low dilutions of the serum. On December 12, seventeen days after the operation, the patient's feces were examined for paratyphoid bacilli. Endo's medium was used for the plates. No paratyphoid bacilli were found.

In the case just described we have the picture of a typical chronic cholecystitis, produced by an organism which corresponds in every way with Brion and Kayser's Type A of paratyphoid bacillus. This bacillus belongs to a group of pathogenic bacteria, intermediate between the typhoid bacillus and *Bacillus coli communis*, which has attained considerable importance for animal and human pathology. To this group belong Gärtner's *Bacillus enteritidis*, the two types of paratyphoid bacillus, *Bacillus typhi murium*, *Bacillus suipestifer* and various meat-poisoning bacilli. There has been considerable disagreement among those who have studied these organisms as to whether they could be definitely differentiated. Bonhof,[6] for example, concluded that the bacillus of mouse typhoid, paratyphoid bacillus Type B, and *Bacillus enteritidis* differed in their pathogenicity for the intestines, but could not be distin-

Digitized by Google

guished by either cultural, agglutination or bacteriolytic methods. On the other hand, Bock,[7] Kutscher and Meinicke,[8] Trautmann,[9] and others, after carrying out elaborate agglutination tests, were able to separate Gärtner's bacillus from the rest of the group. Bainbridge,[10] in addition to the agglutination tests, made use of Castellani's "absorption method." By means of this laborious procedure he succeeded not only in separating *Bacillus enteritidis* from the paratyphoid bacillus Type B, and *Bacillus suipestifer,* but also in drawing a distinction between the two latter organisms themselves. Bainbridge asserts that the *Bacillus typhi murium* has no existence as a definite type. All of these investigators agree that the paratyphoid bacillus, Type A, stands quite apart from the rest of this group in both cultural and agglutination reactions.

The case which I have reported bears a striking resemblance to the one reported by Blumenthal[11] in 1904. His patient, a woman, 46 years old, gave no history of typhoid or paratyphoid fever. At the operation there were found thirty-six gall-stones, cultures from which gave a pure growth of the paratyphoid bacillus, Type A. The agglutination test was positive at a dilution of one to three hundred.

In 1903 Pratt[12] reported a case of cholelithiasis in a girl, 18 years old, who was operated on four years after an attack of fever diagnosed as typhoid. Cultures from the gall-bladder and from the stones gave a pure growth of the paratyphoid bacillus, Type B. The patient's serum agglutinated her own organism, but had no effect on the typhoid bacillus.

Lorey's[2] case is similar to Pratt's. A young man, 22 years old, giving a history of typhoid fever two years previous to his attacks of gall-stone colic, underwent an operation. Four stones were found in the gall-gladder. Cultures from the gall-bladder mucosa showed a pure growth of the paratyphoid bacillus,

Digitized by Google

Type B. The patient's serum agglutinated his own organism, as did also the serum from two cases of paratyphoid fever.

Evers and Mühlens[13] record a case of a woman, 38 years old, who gave a history of three weeks' illness, characterized chiefly by nausea, vomiting and diarrhea. Two days before the operation she was suddenly taken with colicky pains in the gall-bladder region, and severe icterus developed. There was no history of typhoid or paratyphoid fever. The gall-bladder contained considerable pus and many small stones. A pure culture of the paratyphoid bacillus, Type B, was obtained from the pus. Several strains of this organism were agglutinated at a 1-200 dilution of the patient's serum. The organisms were also found in the feces. It is interesting that another woman in the same pavilion developed gastro-enteritis shortly afterward, and the paratyphoid bacillus, Type B, was isolated from the stools.

Zimmer[14] has recently reported a case of paratyphoid cholecystitis which was diagnosed from a bacteriologic examination of the feces. The paratyphoid bacillus, Type B, was isolated. This organism was agglutinated by the serum from a case of paratyphoid fever, but the patient's serum failed to agglutinate his own organism. There was no surgical or postmortem examination in this case.

Forster and Kayser[15] examined the bile of 148 cadavers for bacteria, and found the paratyphoid bacillus only once, and that in a case of diabetes mellitus. The gall-bladder contained two stones. The bile gave a pure culture of the paratyphoid bacillus, Type B, but cultures from the interior of the stones were sterile. In this case there was no history of typhoid fever or paratyphoid fever. The identity of the bacillus was established by "the usual cultural and immunity reactions."

Digitized by Google

In addition to these six cases of paratyphoid cholecystitis, several observers have found paratyphoid bacilli in gall-stones that showed no pathological changes.

Libman,[16] as far back as 1902, isolated the paratyphoid bacillus from the gall-bladder in a paratyphoid fever patient who was operated on for suspected gall-bladder disease. The gall-bladder was distended with thick dark bile which could not be pressed out. After the operation, intense jaundice developed and the patient died on the following day. At the autopsy, however, the gall-bladder and bile ducts showed no changes.

Lucksch[17] has reported a case of paratyphoid fever that came to autopsy. Cultures from the bile showed the organism, but there were no inflammatory changes in the gall-bladder.

The interesting features in connection with my case are the following:

1. The absence of a history of typhoid or paratyphoid fever. Two hypotheses may be advanced in explanation of this: The attack of fever was a very mild one or the case was one of primary paratyphoid infection of the gall-bladder. Müller,[18] Blumenthal,[11] Forster and Kayser,[15] Churchman[19] and others have reported analogous infections with the typhoid bacillus. In the cases of paratyphoid cholecystitis reported by Blumenthal, Evers and Mühlens, and Forster and Kayser, there was no history of any previous attack of fever.

In this connection it is interesting to consider the cases of febrile icterus in which there have been found agglutinins for the typhoid, paratyphoid and other intestinal bacteria. Rostoski,[20] for example, studied forty-one cases of icterus, and found that the serum from almost half of them agglutinated the typhoid bacillus. Some observers, such as Rostoski, and Lüdke,[21] believe that the reaction is often due to molecular

Digitized by Google

changes in the blood, but Christian[22] thinks that the phenomenon when actually present is caused by an infection of some part of the biliary tract. Netter and Ribadeau-Dumas[23] have reported sixteen cases of febrile icterus, in fourteen of which the paratyphoid bacillus, Type A, was agglutinated by high dilutions of the patient's serum. Of the two remaining cases, one agglutinated the Type B of paratyphoid bacillus, and the other Gärtner's bacillus. These observers consider the paratyphoid bacillus, Type A, the predominant exciting agent in febrile icterus.

2. Another interesting feature of the case which I have just reported was the marked agglutinative power of the patient's serum. In a dilution of 1-200 there was complete agglutination of her own organism at the end of one hour. The agglutinations were also specific, the serum having little or no effect on the typhoid or paratyphoid bacillus, Type B, but acting readily on other strains of the A type. The agglutination reactions were also positive and specific in the other cases of paratyphoid cholecystitis, to which I have already referred.

3. One other feature of this case is worthy of mention. No paratyphoid bacilli were found in the feces when it was examined seventeen days after the operation. Unfortunately, no examination was made before the operation or immediately after it. The patient, however, had most probably been a paratyphoid carrier. The cases reported by Lorey, Blumenthal, Zimmer, and Evers and Mühlens all showed paratyphoid bacilli in the feces. In Zimmer's case the diagnosis was made by the positive findings in the feces. Nearly all investigators are agreed that the source of the bacteria in typhoid and paratyphoid carriers is in an infected gall-bladder. That the gall-bladder may act as a reservoir for these organisms is evident from the fact that after removal of the infected viscus the

Digitized by Google

bacilli, as a rule, disappear from the feces. In cases in which they persist after removal of the gall-bladder, an infected common duct is probably the focus from which the bacteria are discharged.

A considerable amount of experimental work has been done in the effort to define clearly the relation of typhoid and paratyphoid fever to the gall-bladder. Blackstein and Welch[24] injected typhoid bacilli intravenously into rabbits, and found that long after the other organs were sterile the gall-bladder contained them in large numbers. In one of their cases typhoid bacilli were found in the gall-bladder one hundred and twenty-eight days after the injection.

Forster and Kayser[15] repeated these experiments, with similar results. They found that the same conditions obtained when the bacilli were injected directly into the gall-bladder.

Dörr[25] carried out some experiments which seemed to show conclusively that the bacilli reach the gall-bladder by way of the blood-stream rather than by means of an ascending infection from the intestine. Dörr employed subcutaneous and intraperitoneal injections of typhoid bacilli, as well as administration by mouth, with negative results. After intravenous injections, however, the gall-bladder contained large numbers of bacilli. Ligation of the cystic duct before the intravenous injection prevented the entrance of the bacilli into the gall-bladder, while ligation of the common duct had no such effect. Dörr concluded from his experiments that the bacilli were excreted from the circulation by the liver, and then passed into the gall-bladder.

Chiarolanza[26] has recently repeated these experiments and demonstrated the presence of typhoid bacilli in the gall-bladder even after the cystic duct was ligated. Chiarolanza also found

Digitized by Google

typhoid bacilli in the small intestine after ligation of the common duct.

J. Koch[27] made a histological study of the gall-bladder in typhoid cholecystitis, and also in animals injected with the typhoid bacillus, and could find small nests of bacilli in the terminal capillary ramifications of the gall-bladder mucosa. Some of these nests had already ruptured into the gall-bladder lumen, after producing more or less necrosis of the tissue about them.

Chiari's[28] investigations led him to conclusions quite different from those of Koch. Chiari isolated the typhoid bacillus from the gall-bladder of seven out of eight cases of typhoid fever that came to autopsy. In only two of these cases, however, did the gall-bladder show pathological changes. Chiari could find no bacteria or clumps of bacteria in the smaller blood-vessels, and was convinced from his studies that infection, when it did occur, was from within outward.

Forster[29] takes the same position. He believes that when typhoid or paratyphoid bacilli are taken into the system they pass at once into the circulation and reach a lymph-gland where they multiply. This occurs during the period of incubation. Later they appear in the circulation, are taken up by the liver and pass into the gall-bladder where they again encounter conditions favorable to multiplication. The bacilli pass out from the gall-bladder into the intestine and infect Peyer's patches. Working on this theory, Forster tried various methods of flushing out the gall-bladder in typhoid carriers, but this mode of treatment was not efficacious.

If the results of Koch and Chiarolanza can be corroborated, we have in them a satisfactory explanation of the mode of infection in typhoid and paratyphoid cholecystitis. The demonstration by Chiarolanza of typhoid bacilli in the small intestine,

Digitized by Google

even after ligation of the common duct, suggests that the infection of Peyer's patches is also hematogenous and accomplished by the passage of bacilli from the terminal intestinal capillaries into the surrounding tissue, rather than, as Forster contends, a sequel to the infection of the gall-bladder.

NOTE.—I reported this case of paratyphoid cholecystitis before the New York Pathological Society in December, 1909. In the discussion which followed, Dr. Rosensohm reported a case of gall-bladder disease, the patient operated on at the Mt. Sinai Hospital. The gall-bladder was filled with calculi. Cultures gave a pure growth of the paratyphoid bacillus, Type A, which was agglutinated by a 1-100 dilution of the patient's serum.

41 East Seventieth Street.

REFERENCES.

From the Pathological Laboratory of the Presbyterian Hospital, New York.

[1] Smith: Allbutt and Rolleston's System of Medicine, I, 1157.

[2] Lorey: München. med. Wchnschr., 1908, LV, 15.

[3] Schottmüller: Ztschr. f. Hyg. u. Infektionskr, 1901, XXXVI, 368.

[4] Brion and Kayser: München. med. Wchnschr., 1902, XLIX, 611.

[5] Proescher, F., and Roddy, J. A.: A Report of Forty-Eight New Cases of Paratyphoid Fever (Type A), The Journal, A. M. A., 1909, LII, 470.

[6] Bonhof: Arch. f. Hyg., 1904, I, 222.

[7] Bock: Arb. a. d. k. Gsndhtsamte, 1905, XXIV, 238.

[8] Kutscher and Meinicke: Ztschr. f. Hyg. u. Infkr., 1905, LII, 301.

[9] Trautmann: Ztschr. f. Hyg., 1903, XLV, 139.

[10] Bainbridge: Jour. Path. and Bacteriol, 1909, XIII, 443.

[11] Blumenthal: München. med. Wchnschr., 1904, LI, 1641.

[12] Pratt: Boston Med. and Surg. Jour., 1903, CXLVIII, 137.

[13] Evers and Mühlens: Deutsch. Mil.-ärztl. Ztschr., 1909, XXXVIII, 366.

[14] Zimmer: Mitt. d. Gesellsch. f. inn. Med. u. Kinderh. in Wien, 1908, VII, 34.

[15] Forster and Kayser: München. med. Wchnschr., 1905, LII, 1473.

[16] Libman: Jour. Med. Research, 1902, VIII, 168.

[17] Lucksch: Centralbl. f. Bacteriol., 1903, XXXIV, Abt. I, Orig. 113.

[18] Müller: Ztschr. f. Heilk., 1905, VII, 310.

[19] Churchman: Bull. Johns Hop. Hosp., 1909, XX, 89.

[20] Rostoski: Sitz-Ber. d. phys-med. Gesellsch., Würzburg, 1904, p. 69.

[21] Lüdke: Deutsch. Arch. f. klin. Med., 1904, LXXXI, 34.

[22] Christian: Boston Med. and Surg. Jour., 1907, CLVI, 536.

Digitized by Google

[23] Netter and Ribadeau-Dumas: Compt. rend. Soc. de Biol., 1905, LVII, 436, 450.
[24] Blackstein and Welch: Bull. Johns Hop. Hosp., 1891, II, 96, 121.
[25] Dörr: Centralbl. f. Bacteriol., etc., 1905, XXXIX, Abt. I, Orig. 624.
[26] Chiarolanza: Ztschr. f. Hyg. u. Infektionskr., 1908, LXII, 11.
[27] Koch, J.: Ztschr. f. Hyg. u. Infektionskr., 1908, LXII, 1.
[28] Chiari: Verhandl. d. deutsch. path. Gesellsch., 1907, XI, 143.
[29] Forster: München. med. Wchnschr., 1908, LV, 1.

Digitized by Google

XXI.

ACUTE, SPONTANEOUS PERFORATION OF THE BILIARY SYSTEM INTO THE FREE PERITONEAL CAVITY.*

A report of six cases from the Presbyterian Hospital of New York and 108 cases from the Literature.

By CLARENCE A. MCWILLIAMS, M.D., ASSISTANT VISITING SURGEON.

Having personally had two cases of perforation of the gall-bladder into the free peritoneal cavity, my attention was called to the subject and I have gone over all the histories of operations on the biliary system in the Presbyterian Hospital for the past fifteen years. There were 365 such operations, with six cases in which the bile had extravasated through a perforation in the biliary system into the more or less free peritoneal cavity. Such perforations are rare, and not many of these cases occur in the experience of any one man. One is, however, likely to meet with such a case at any time, and one should not be taken off one's guard when confronted with such a condition.

It has seemed to me that something might be learned from going over the recorded cases in the literature. I have been able to collect 108 cases of perforation into the free peritoneal cavity and a table of them appears at the end of this article.

*Read before the New York Surgical Society, November 22, 1911.

(*Reprinted from the Annals of Surgery, February,* 1912.)

Digitized by Google

The six cases which occurred in the Presbyterian Hospital are as follows. But two of these six died.

CASE I. Chinaman, thirty-eight years of age. History 13622, September 25, 1911. Ambulance. History difficult to get and through an interpreter. Slight attack similar to present illness several years ago. Attacks of digestive disturbances. Onset sudden three days ago, with epigastric pain, nausea, and vomiting. Next day pain localized in right lower quadrant, radiating up and down. No vomiting since yesterday but pain is getting steadily worse. Bowels constipated for three days.

Examination.—Well nourished but prostrated. Leucocytes, 10,000; polymorphonuclears, 85 per cent.; pulse, 114; temperature, 101°. Abdomen full, distended generally though not extreme. Does not move with respiration in lower half and only slightly above. Whole abdomen feels resistant and walls are tense, preventing palpation freely. General muscular rigidity but most marked in right lower quadrant. General tenderness but acute only in right lower quadrant. A little above McBurney's point, where slight pressure causes pain, there is sense of a mass about the size of a large orange, exquisitely tender. Tympany everywhere except a little dullness in each flank.

Clinical Diagnosis.—High gangrenous appendicitis with spreading peritonitis.

Operation at once. Dr. McWilliams, at midnight, September 25, 1911. Gas and ether. High McBurney incision made. On opening peritoneum turbid, greenish-yellow, somewhat purulent, odorless fluid escaped, being free in cavity. Appendix not located. Cæcum involved in mass of recent adhesions. On passing finger upward separated weak adhesion, following which there was a gush of great quantity of bile mixed with flocculi. Right rectus incision over gall-bladder emitting large amount of bile. Omentum adherent to liver. Separated. Great difficulty in finding gall-bladder. It was found deep in posteriorly, very small and contracted, with a perforation, admitting tip of finger, in cystic duct directly over a large curved calculus. Gall-bladder incised and stone removed. On account of patient's condition nothing further done. Tube sewn into bladder and two tubes into Morrison's pouch. Closure about tubes.

Patient in poor shape after operation. Infusion 1200 c.c. salt solution with adrenalin 20 minims. Died next morning, eight hours after the operation. No autopsy.

Result of Cultures.—Smears, many pus-cells but no bacteria. Cultures. Predominating cocci in groups and a few negative bacilli.

We have in this case both the mechanical and infectious factors present. How much the infection had to do with the perforation it is difficult to say, but the stone had certainly

Digitized by Google

ulcerated the duct which was tightly drawn over the large stone. Had this man been operated upon on the first day of his illness, there might have been a chance for his life, but the form of infection, streptococci, is against any form of peritonitis recovering. It was also unfortunate that a diagnosis of appendicitis was made, for there was evidence of beginning adhesions about the cæcum, and had the gall-bladder region been opened at the beginning the peritoneal cavity would not have been so soiled.

CASE II. Man, aged sixty-seven years. Admitted August 20, 1911. Ambulance at 3 P. M. Operator Dr. McWilliams. Complaint, pains all over abdomen, mostly on right side. About two months ago patient had very severe attack of pain on right side just below ribs. Had to stop work for a week. Had constant attacks of nausea and vomiting. Appetite poor. Bowels constantly constipated. Pains gradually wore away. Well until yesterday when suddenly, while bending over a lathe, sudden abdominal pain, so severe that patient could not stand up and knees were drawn up while in bed. Pain was all over abdomen, but most of the tenderness below ribs and lower down on right side. Nausea was extreme and he vomited a great deal of greenish-brown fluid. Took cathartic and bowels moved well.

Examination.—Markedly prostrated, tongue heavily coated. Pulse 88, fair force, slightly irregular. Temperature 99.4°, leucocytes 24,000, polymorphonuclears 92 per cent. Abdomen held rigid, tympanitic over all, with partial obliteration of normal liver dullness. Entire right side of abdomen very rigid, boardlike as one finds in stomach perforation, extending to a less degree to left rectus. Excessive tenderness just above right internal ring. Left inguinal hernia, but easily reducible. Right external ring dilated but no impulse. No peristalsis could be heard over abdomen. Some tenderness on rectal examination.

Clinical Diagnosis.—Intestinal obstruction, origin unknown.

Operation at once. Kammerer incision over appendix. Bile poured out of wound in great amount. Removed by passing Blake's irrigating tube into pelvis. Vertical right upper rectus incision. Large amount of bile escaped with particles of fibrin mixed with it, and pus. Large perforation of fundus. No stones in bladder, but finger felt a large rough one impacted in cystic duct. Extracted with Blake's gall-stone forceps. Common duct free, but foramen of Winslow obliterated. Rubber tube sewn into opening in gall-bladder, and the edges of the bladder inverted about the tube by two purse-string sutures of plain catgut. Two rubber tubes, one containing gauze strip, into Morrison's pouch. One tube in appendix wound. Both wounds closed about tubes.

Digitized by Google

Patient made an uninterrupted recovery. Discharged, September 22, to his own physician, with a granulating wound discharging a small quantity of bile. Seen six months later. Perfectly well. Fistula healed in two months.

CASE III. Man, twenty-six years of age. Admitted January 20, 1907. Operator, Dr. McCosh. Private patient. Three years ago attack of jaundice, grew deeper for a few days, and one night attack of pain for an hour in right hypochondrium. Five months ago similar attack but much severer, lasting for five days and with deep jaundice. Four months ago another attack and also three weks ago, which last attack has not as yet subsided. Skin jaundiced, stools clay-colored. Pain now severe in right hypochondrium.

Examination.—Prostrated, deeply jaundiced. Abdomen held rigid on entire right side, most markedly so in right upper quadrant. Tenderness over whole of right side of abdomen and dullness over gall-bladder region. Temperature 101°, pulse 104, leucocytes 11,660, polymorphonuclears 80 per cent.

Operation at once. Incision over gall-bladder, which was found gangrenous and perforated at fundus, and surrounded by large amount of bile and pus. No stones found anywhere nor in common duct. Cholecystectomy. Tube into stump of gall-bladder. Uninterrupted recovery.

CASE IV. Male, forty-nine years old. On Medical Division for nine days. While there temperature 99.5° to 102.4°. Leucocytes on admission 36,000, on day of operation 40,000. When brought in gave a history that three weeks ago, severe frontal headaches and diarrhœa. Two weeks ago began to have pain in right upper quadrant. Next day went to bed with a temperature of 102°. Chill the day before admission. No vomiting, bowels loose. Two days before admission became acutely delirious and was then brought into the hospital.

Examination.—Large mass made out occupying right side of abdomen, tender, and muscular rigidity. Dullness over it, evidently an abscess.

Operation, Dr. Brown, September 20, 1901. Incision through right upper rectus, giving exit to large amount of bile and pus with a stinking odor. Numerous adhesions. Gall-bladder perforated at fundus, and from it was removed a single, non-fascetted stone, the size of a pigeon's egg. Tube drainage of bladder and a second tube into the space below the gall-bladder.

Uninterrupted recovery. Discharged October 19, 1901, with a sinus still discharging pus.

CASE V. Male, forty-nine years of age. Private patient of Dr. Blake. Three months ago vague shooting pains, worse when stomach was empty and relieved by food. No vomiting. Alkali treatment, and got well. Two days before admission, marked abdominal discomfort, vague in character, localized in right upper quadrant of abdomen and small of back. Sense of fatigue and constant desire for food. These symptoms continued until to-day, when he was seized with sharp pain localized in right upper quadrant.

Examination.—Acute tenderness in right side of abdomen, more so over gall-bladder, with great muscular rigidity. No mass could be made out.

Digitized by Google

Operation at once. Bile free in abdomen and a collection of it in right gutter. Gall-bladder gangrenous in spots and contracted. Interior full of small stones. Gall-bladder removed. General abdominal irrigation with Blake's irrigating tube. Tube into stump and two tubes in bed of gall-bladder.

Uninterrupted recovery. Smears and cultures taken at the time of the operation were sterile.

Case VI. Male, thirty-one years of age. Operator, Dr. Hawkes, March 17, 1906. An Italian. Heavy drinker up to three years ago. Never an attack similar to present one, which began four days before admission with sudden onset of pain under right lower ribs, with chill, fever, nausea, vomiting, prostration and constipation. Pain did not radiate and was increased by movements in bed. Vomitus contained food remnants, no bile nor blood. Pain continuous ache, gnawing, not colicky, and none in shoulder. Did not notice that he was jaundiced until attention was called to it in hospital.

Examination.—Temperature 101°, pulse 120, leucocytes 15,000, polymorphonuclears 84 per cent. Exquisite tenderness and rigidity of right rectus especially its upper part. Respiratory movements much limited on right side. Somewhat distended. On account of rigidity and tenderness no mass could be made out, but marked flatness below right costal arch. Deeply jaundiced.

Operation: Liver edge found adherent to transverse colon and to anterior abdominal wall by recent adhesions. Gall-bladder not made out. On breaking through adhesions toward duodenum, profuse discharge of thick, creamy, foul-smelling pus mixed with bile. Rubber drainage tube, surrounded by gauze.

After-course.—Jaundice never lessened. Profuse discharge of bile from wound. Had occasional chill and sweat. Lost ground gradually. Temperature remittent, as high as 103° some days. Leucocytes on April 3, 39,000, on the 5th, 62,300, with polymorphonuclears 91.5 per cent. Went into coma and died on the twenty-first day after operation. No autopsy.

Pathology.—The ordinary peritonitis arising from the gall-bladder is usually due to simple diffusion of infection through its walls to the peritoneum. It may result in a collection of pus of greater or less extent about the gall-bladder, but it is almost always well walled in by adhesions and represents a beautiful example of curable localized peritonitis. A very rare condition indeed is a generalized peritonitis due to lack of adhesions and without perforation. Korte has, however, reported three such cases. There are four cases recorded in the literature in which bile was found free in the peritoneal cavity, but in which there was no perforation of the

Digitized by Google

biliary system. One is by Richardson, who says: "In one instance I found the right upper quadrant flooded with bile which had escaped from a gall-bladder that was apparently normal. Drainage was successful." Similar cases are recorded by Clairmont, Schievelbein, and Finsterer.

Much more serious, however, in its consequences and with a mortality rate not much under that of perforations of the alimentary tract must be ranked perforations of the biliary system into the free peritoneal cavity. Normal bile is sterile and is fairly well tolerated in large amounts and for a long time by the peritoneum, in which is set up a chronic irritation which results in the walling-in of the bile. This is well illustrated in traumatic rupture of the gall passages. Witness the interesting case of Garre, in which, two months after the injury, a large quantity of bile was evacuated and the patient was then cured by hepatocholangio-enterostomy; or the case of Hildebrandt, in which operation on the twenty-third day after the injury disclosed a tear in the hepatic duct, recovery following.

In rabbits, Noetzel has demonstrated that after an aseptic laparotomy the gall-bladder can be incised and left to drain into the free abdomen, after which the abdominal wound is tightly closed. The animals regularly survived this procedure. In a second set of experiments, he demonstrated that, after opening the peritoneum, the animals recovered after infections were introduced into the cavity, of certain amounts of *Staphylococcus aureus,* in other animals of *Bacillus coli communis,* in others of *typhoid bacilli,* and in others of *streptococci.* He also demonstrated that if even smaller amounts of these organisms were injected into the abdomens of animals and at the same time, their gall-bladders were incised and left open in the abdomens and the abdominal wounds were then closed,

Digitized by Google

the animals regularly died of septic peritonitis. These experiments show the deleterious effect of bile in contact with peritoneum in exalting the virulence of the organisms. In addition bile diminishes phagocytosis, and by this double mechanism it decreases the means of natural defense of the peritoneum toward infection. Conradi has shown that bile for typhoid bacilli is a good culture medium. He has also shown that the addition of bile to a normal blood-serum promptly does away with the bactericidal properties of such serum, for, if we take 0.3 c.c. normal guinea-pig serum in a dilution of 1 to 80, we will find that this amount will kill 20,000 typhoid bacilli in two hours. If we now add 1.1 c.c. of bile to the same amount of normal guinea-pig serum, a bactericidal effect of the serum cannot be demonstrated, but on the contrary the added typhoid bacilli will grow without any hindrance.

Neufeld and Handel have shown through experiments that this paralytic effect upon the bactericidal quality of the blood evidently rests upon the energetic binding of the compliment with the salts of the bile. According to them, sodium taurocholate unites not only with the bactericidal complement but also with the hæmolytic. These experiments explain why such a rapid destruction of the animals takes place when bile is mixed with weak infections in the abdomens of the animals. There results a great decrease in the bactericidal properties of the serum poured out into the abdomen in response to the irritation, and the animals die of sepsis, or rather of septic peritonitis.

Etiology of Perforation.—We may group these as follows:

1. Rupture from overstretching, with or without stones.

2. Perforation from pressure of a stone upon the wall, causing ulceration.

Digitized by Google

3. Perforation from gangrene, due to (*a*) thrombosis of vessels, with or without stones; (*b*) cutting off of circulation from pressure of a stone; (*c*) diphtheritic, ulcerative infection of wall, with or without stone.

It is not necessary to do more than state these facts, and discussion of them would be superfluous. The important point from a prognostic and therapeutical aspect of the subject is the amount and virulence of the infection present in the biliary system at the time of the perforation. We may group the cases then into two classes:

1. Those patients with latent stones in their biliary systems who have had no attacks of infection for some time. The contained bile is evidently not perfectly sterile, and if one were to take cultures from it, one would find numerous pathogenic bacteria, but they are actually well tolerated. Such a bladder may become distended, due to obstruction from impaction of a stone in the cystic duct or neck of the bladder, or, if no stones be present, from stricture of the duct with a coincident swelling of the mucous membrane, or from a kink in the cystic duct. Its walls may become paper-thin from overstretching, or very brittle from old chronic inflammation, or weakened from ulceration due to the pressure of a stone. In such conditions it may be brought to sudden bursting by reason of the compression exercised upon it by the abdominal muscles in the act of coughing, or vomiting, or of bending over. There results a pouring out into the peritoneal cavity of a quantity of bile of a little septic character. It is mechanical in origin and infection plays a small part in the process. There is no great reaction of the peritoneum as a result of its contact with the bile, save in the formation of more or less abundant fibrinous adhesions. An intervention leads to a good prognosis, provided it be not too long delayed,

Digitized by Google

for it prevents the development of secondary infectious complications which are likely to follow if one abandons the patient to his own means of defense; for, as we have already seen, the previously existing latent infection may become exalted in its virulence, due to the bactericidal effect of the serum poured out into the peritoneum being diminished by reason of its mixture with bile, while at the same time there is no exit to the infectious fluid which itself is a good culture medium. In addition, one must not lose sight of the fact that infectious agents may emigrate directly from the intestinal canal into the peritoneal cavity through the perforation. Blake reports a case in which there was a primary abscess about the gall-bladder which later burst into the general peritoneal cavity with a fatal issue.

2. The second and grave type is that in which the perforation is directly due to infection and its results. There is present a more or less acute cholecystitis, with obstruction, and the gall-bladder may rupture from increasing tension or through a spot of gangrene of its wall, which may occur because of the cutting off of the circulation through thrombosis of its vessels or by reason of the pressure of a stone. Or an abscess situated in the wall may rupture, thus weakening the wall and leading to a perforation through distention. The process is much less mechanical than infectious, *i.e,* the calculus plays a secondary rôle, and may be entirely absent. Obstruction may occur through the swelling of the mucous membrane dependent upon the intense inflammation of the mucous membrane of the cystic or common duct. The perforation may be very sudden and acute, without surrounding preparatory adhesions, so that the peritoneal cavity is inundated by a very septic fluid with a resulting more or less general peritonitis. The prognosis in such a case may be very grave and may tax

Digitized by Google

the surgeon's judgment to the utmost. A contracted gall-bladder will not contain very much fluid and, if, at the time of rupture, there be no relief in the obstruction, it will take several days for much bile to collect in the abdomen. If, on the other hand, the gall-bladder be thin-walled and much distended, the amount of fluid escaping through the perforation will be very large.

Between these two types there are all grades of commingling. In some cases there is difficulty in saying which element predominates, the mechanical or the infectious. It would seem in some patients with chronic empyema of the gall-bladder as though the calculus and the microbes mutually agree to end in perforation. In the vast majority of cases, perforation of the walls does not progress so rapidly as to take the peritoneum unawares, so that adhesions have time to form. In the rare case, however, with rapid perforation, no adhesions are present, and the rapidity and extent of the consequent peritonitis will depend on the amount of the extravasated bile or pus, and the virulence of its contained organisms. A pinhole perforation of a contracted bladder with a stone blocking the escape of bile will cause the development of a slow, more or less localized peritonitis, while a large sudden perforation in a much distended and infected bladder will cause an overwhelming general peritonitis similar to that which we find in perforation of the stomach or duodenum.

The gall-bladder mucosa presents numerous alveoli formed by fibromuscular bands. They are of various sizes and shapes, and in them we often find large or small calculi which are difficult to enucleate and are, as it were, let into the wall. The alveoli also contain septic fluid and are therefore an excellent culture medium for micro-organisms. The result is an ulcerative process which may lead to perforation and peritonitis.

Digitized by Google

Dieulafoy says that the *Bacillus coli communis* seems to be an essential agent in the ulcerative process. Certain it is that nothing can be elicited from the reported cases as to the bacteriology of these perforations, for in but very few cases have cultures been taken at the time of operation.

Of 90 cases in which the situation of the perforations is mentioned, 82 of them, or 91 per cent., occurred in the gall-bladder, 3, or 3.3 per cent., occurred in the cystic duct, 4, or 4.4 per cent., in the common duct, while 1, or 1.1 per cent., occurred in the hepatic duct.

In 80 out of 108 cases, or 74 per cent., stones were found at the time of the operations for perforation. From this fact we may infer that calculi, single or multiple, are a great factor in causing perforation. In 14 cases, or 13 per cent., it was found that no stones were present after adequate search. In the 14 remaining cases, or 13 per cent., stones may or may not have been present, as no mention is made of them. Many of these cases were simply drained without search being made for stones.

In but 9 cases is it distinctly stated that gangrene was present. It usually was simply a small area of gangrene, and through this the perforation took place.

Frequency of Occurrence.—That general peritonitis due to a perforation into the free cavity is a rare occurrence the following table of frequency will indicate. No one operator has had many cases, and our ideas of the lesion can only be gained by putting together the single observations of many. Because of the heavy mortality following perforation of the biliary system into the free peritoneal cavity, probably most of the isolated cases have not been reported, so that to gain informa-

Digitized by Google

tion as to the relative frequency one must go through the reported series of operations on the biliary system.

	No. of Operations.	Cases of Perforation.
Adâm	112	3
Robson	539	3
Ochsner	48	1
MacLaren	80	4
Kehr	1526	1
Korte	254	7
Jenckel	210	8
Ferguson	46	1
Pres. Hosp. (McWilliams)	365	6
Totals	3180	29*

* Or .9 per cent.

Thus we see that the occurrence of perforation into the peritoneal cavity is a very rare accident indeed. There were but 29 cases in 3180 biliary operations. One almost never finds it mentioned in text books or articles on the differential diagnosis between acute lesions in the upper abdomen. While the lesion is a rare one, it is not so infrequent as one would be led to suppose from the small number of cases published. Are not many of these cases unrecognized? If a calculus completely obstructs the cystic duct, there will be nothing but pus in the gall-bladder with the formation of a purulent peritonitis after perforation, without free bile in the cavity. If there be nothing in the history to call the surgeon's attention to the gall-bladder, there may be nothing found on opening the abdomen in the usual positions to cause one to suspect that the gall-bladder is at fault, and a right diagnosis may not be made until the autopsy table is reached.

Age and Sex of the Patients.—There were 99 patients whose ages are given, and the average age was 50.2 years. The youngest patient was No. 49, whose age was 21 years, while the oldest was No. 44, who was 80 years of age. The

Digitized by Google

disease is one of advanced life as the following statistics show: Between 20 and 30 years: recovered 7, died 2; between 30 and 40 years: recovered 7, died 5; between 40 and 50 years: recovered 14; died 9; between 50 and 60 years: recovered 14, died 21; between 60 and 70 years: recovered 7, died 7; between 70 and 80 years; recovered 4, died 2. Before 50 years there were 44 cases, while there were 55 cases beyond 50 years. Before 50 years there were 63 per cent. of recoveries, while there were but 46 per cent. after 50. How great an influence diseased blood-vessels have upon necrosis and gangrene of the gall-bladder it would be difficult to say.

The statistics as to sex are as follows: Females: recovered 35, or 56 per cent.; died 27, or 44 per cent.; total 62, or 60 per cent. Males: recovered 19, or 46 per cent.; died 22, or 54 per cent.; total 41, or 40 per cent. From this we find that 60 per cent. of the cases occurred in women and that they stand the disease better than men, the mortality in women being 44 per cent. as against 54 per cent. in men.

Symptoms and Diagnosis.—Peritonitis due to perforation is a most treacherous complication. It may come on during an attack of biliary colic, and as the symptoms in each case are similar (violent pain and vomiting), it may cause serious mistakes. If an attack of colic leaves a very tender gall-bladder region, the patient should be operated upon at once, but if, for any reason, this be not done, then the patient should be very carefully watched. The degree of spread of infection from the gall-bladder is the important point, as judged by the change in the extent of the abdominal rigidity, tenderness, fever, pulse, leucocytes, and polymorphonuclears. All the cases of perforation were ushered in by pain. If a cholecystitis had been present, then the character of the pain

Digitized by Google

changes. From being a more or less dull, continuous localized ache it becomes generalized over a greater extent of the abdomen, down the right side, and to the navel. There may be in some cases at the time of perforation a sense of temporary relief as the tension of the distended gall-bladder is relieved by the fluid effused from its cavity. This is followed by the signs of peritonitis, more extensive rigidity and tenderness, nausea, vomiting, distention, rapid pulse, temperature, and prostration. In some cases perforation is sudden and without warning, and the symptoms are then like those in perforation of a stomach ulcer. More than one patient with perforated biliary system has been operated upon with the diagnosis of perforated gastric ulcer. In this type we find sudden intense pain, which can not often be localized but is said to spread over the whole abdomen. The patients become rapidly prostrated, collapsed, vomiting soon follows, and the rigid and tender abdomen becomes distended, flatus ceases to pass, and the pulse becomes rapid and irregular. After a few hours the patient may rally, having the "interval of repose" seen in all forms of perforation within the abdomen.

The tendency of the material which escapes from the gall-bladder is to gravitate downward along the outer side of the ascending colon into the appendical region, which becomes tender and rigid, and at once gives rise to the opinion that one has to deal with a perforated appendix. This is a very frequent mistake in these cases. A careful history and the location of the early symptoms, such as pain and muscular rigidity in the region of the gall-bladder, will enable us often to make a differentiation. A right diagnosis will spare the patient an unnecessary incision and the loss of valuable time with the added danger of opening up protective adhesions. In both my own cases, a wrong diagnosis was made, in one case being due

Digitized by Google

to the inability to get a proper history. A Chinaman (Case I) who spoke no English was operated upon under the diagnosis of perforated appendix, and an appendix incision made. It was not until a large collection of bile was opened into in searching for the appendix that the diaguosis was made of perforated gall-bladder. Thus the gravely infected bile was spread widely, and likely contributed to the fatal outcome, in addition to the added shock of the prolonged operation. The outcome of my second case was more favorable because the infection was not so virulent, due to the earlier operation. The diagnosis was probable intestinal obstruction of unknown origin. On making a Kammerer incision over the appendix, bile at once flowed out and the diagnosis was at once clear. Other diagnoses have been volvulus (Case 81), intestinal obstruction (Cases 18, 24, 91, 97), intussusception (Case 23), intestinal perforation (Case 98), perforated gastric ulcer (Case 47), perforated typhoid ulcer (Case 65), and appendicitis (Cases 108, 92). One remarkable case is recorded by Kummel, in which a tumor supposed to be ovarian became acutely inflamed, peritonitis followed, with death in two days. The tumor on autopsy was found to be a distended gall-bladder.

The puzzling cases are those in which there is no sudden large amount of effused fluid, but in which there is a steady small leakage. The pain in these cases is not very great in the beginning if the fluid be not very septic. The diagnosis of intestinal obstruction is apt to be made in these cases, due to the pressure of the collection of bile on the intestines and the paralyzing effect of its contained infection.

In 11 cases it is distinctly stated that jaundice was present at the time of the operation. Of these 6 recovered and 5 died. Its presence indicates an advanced case because, if not present

Digitized by Google

at the time of the perforation, it comes on later from absorption of biliary pigment by the peritoneum.

What a large element infection plays in these cases is shown in the relative mortality of operations for traumatic rupture. Thus Rickets reports 28 cases operated upon for traumatic rupture with 22 recoveries, or 78 per cent.

PROGNOSIS AND RESULTS OF OPERATION.

Duration from Perforation to Operation	Recovered	Died	Per cent. of Recover	Per cent. of Deaths
Within 12 hours.....	6	1	85.7	14.3
1 day	10	5	66.6	33.3
2 days	7	7	50.0	50.0
3 days	8	8	50.0	50.0
4 days	2	8	20.0	80.0
5 days	3	4	42.8	57.2
6 days	2	2	50.0	50.0
7 days	1	1	50.0	50.0
10 days	2	1	66.6	33.3
11 days	0	1	....	....
14 days	2	0	....	....
Totals	43	38	53.0	47.0

The above table very graphically represents how important it is for these patients with perforation to be operated upon as soon as possible after the perforation. Thus in 7 cases operated upon within 12 hours of the perforation 6 recovered, or 86 per cent.; of 15 cases reported operated upon when the perforation had existed for one day, 10 recovered, or 66 per cent.; of 14 cases operated upon after two days, 7 recovered, or 50 per cent.; of 16 cases operated upon after 3 days, 8 recovered, or 50 per cent. Operations after four days give a very poor prognosis, for of 10 cases only 2 recovered, or 20 per cent. The recov-

Digitized by Google

eries then increase, due probably to the fact that the patient has developed his opsonins sufficiently to overcome the infection to a greater extent, for of 7 cases operated upon after 5 days, 3 recovered, or 43 per cent. The sixth and seventh days have each 50 per cent. recoveries.

Of the total number of cases that I have obtained from the literature, 108 in number, 56 recovered, or 51.8 per cent., while 52 died, or 48.2 per cent. Rickets reported 160 cases which were not operated upon and of this number but 6 recovered, or only 3.7 per cent. We may say then that without operation a patient with a spontaneous perforation of the biliary system is in a hopeless condition, and even with operation nearly half the patients will die.

Treatment.—Prevention is the key-note in modern medicine. As Korte has said, "To prevent perforation, one should immediately operate when one finds a greatly distended and sensitive gall-bladder with peritoneal irritation." The custom is fairly general of waiting for the disappearance of infectious symptoms in a frank case of cholecystitis. Most of these symptoms will subside and then there is hesitation about operating until another attack occurs. Each attack produces its effect in changing the pathology of the gall-ducts, rendering a subsequent operation more serious for the surgeon and for the patient. In any attack the stretched biliary system may rupture, producing either a local or general peritonitis and rendering an immediate operation imperative.

Perhaps in no acute condition in the abdomen is one compelled to exercise so much judgment at the time of operation as in these perforations into the peritoneal cavity. He who is the keenest observer of the conditions found in the abdomen, who can best estimate the virulence of the infection present,

Digitized by Google

the degree of adhesions, and the pathological conditions present in the gall-bladder system, who can make a good mental estimate of how much or how little the patient can stand, who can get in and get out of the abdomen the quickest, inflicting the least possible trauma, will have the greatest success in these trying cases.

The age of the patient must be taken into account in considering what had best be done. Of 100 patients with perforation into the peritoneal cavity, over 56 per cent. occurred in persons over 50 years of age. These elderly persons do not stand infections of their peritoneum well, for 63 per cent. of patients under 50 recovered, while but 46 per cent. of those over 50 years got well. Everything should be done to minimize shock in these elderly persons.

The old question of cholecystostomy *versus* cholecystectomy is naturally one which must be quickly decided upon as the operation proceeds and the conditions are revealed. I have endeavored to get some light on this question from analyzing the reported cases. If we take the cases which were operated upon within 24 hours of the perforation, there does not seem to be a great deal in favor of one procedure over the other, although the cases are too few to draw any very definite conclusions. This is what one would expect because in these early cases one will find few adhesions, and in order to do an ectomy, one would open comparatively few fresh avenues for spread of the infection. Thus, 20 cases were operated upon within 24 hours after perforation: cholecystostomy: recovered 11, or 68 per cent.; died 5, or 32 per cent.; cholecystectomy: recovered 3, or 75 per cent.; died 1, or 25 per cent. From this we might argue that the balance is in favor of an ectomy in these early cases.

The operative measures in general which have been used in treating these cases, taken as a whole, are as follows with

Digitized by Google

the results: (1) suture of perforation with drainage of peritoneum: recovered 1, or 20 per cent.; died 4, or 80 per cent.; (2) tamponade of the biliary region: recovered 10, or 47 per cent.; died 11, or 53 per cent.; (3) cholecystostomy: recovered 30, or 61 per cent.; died 19, or 39 per cent.; (4) cholecystectomy: recovered 16, or 48 per cent.; died 17 or 52 per cent.

Suture of the perforation needs merely to be mentioned to be condemned, as it violates all our modern ideas of the treatment of biliary diseases.

Simple incision of the abdomen with drainage of the biliary region gave 47 per cent. of recoveries. Cholecystectomy accomplished very little more, 48 per cent. recovering. The best results were obtained with cholecystostomy with which 61 per cent. recovered. Many of the cases with simple incision were in desperate condition, and the gravity of the general state seemed to contraindicate further measures. It is a question open to discussion how much better results would have been obtained had a better means of drainage been provided, in some of the cases. Thus, the case of Korte (No. 31), which died on the eighteenth day, that of Hawkes (No. 95), which died on the twenty-first day after operation, and of others, brings up the question of whether an intervention more direct to the seat of infection with the drainage of the infected bile to the surface would not give better results. Each operator will have to decide this question for himself in each individual case.

How does it stand with cholecystostomy *versus* cholecystectomy? On first sight one is struck with the success of the former as compared with the latter, 61 per cent. of recoveries with cholecytostomy as again 48 per cent. with cholecystectomy. Cholecystostomy for the average operator is the less dangerous procedure, and should therefore be preferred in

Digitized by Google

these perforative cases. But are there exceptions, and, if so, what are they? Cholecystostomy has given brilliant results in some apparently hopeless cases, such as those of Korte, Kummel, Lecene, Mosetig-Moorhof, Thiel, Jaboulay, Whitacre, and others. In other cases the outcome has been such as to suppose that cholecystectomy would have been better. Witness the case of Hirschel (No. 16) who did a cholecystostomy in a patient with acute cholecystitis with gangrene of the neck of the bladder. At first he recovered, but died on the twelfth day of pulmonary gangrene. The same occurrence took place in a patient of Narath (No. 80) on the tenth day. Also the patient of Hartig (No. 12) who had scarcely left the hospital after a cholecystostomy before he had a second perforation of his gall-bladder with a second operation, as a result of which he succumbed. Whitacre's case (No. 86) had two perforations at different times with two different operations with a successful outcome. These secondary ill-results would likely have been avoided by a primary cholecystectomy. The cases with pulmonary gangrene probably had their origin in a persistence of the focus of infection in the bladder gangrene. As a rule, then, we are justified in saying that cholecystostomy should be the operation of choice in cases in which there is little sepsis. In cases, however, where there is a severe infectious cholecystitis with an ulcerative, or gangrenous process, *i.e.*, the grave cases, it were better to remove the focus by a cholecystectomy where this is possible. By this means some of the infecting process will be removed. A drain should always, however, be placed in the stump of the cystic duct, and the peritoneum also be drained. Adhesions should not be broken up to accomplish this except to a slight degree. Should bile be free in the abdomen, it would be well to flush the whole cavity quickly with salt solution and to place a drain possibly in the suprapubic area.

Digitized by Google

Nothing by mouth for a few days (the Ochsner treatment), salt solution by rectum according to Murphy continuously, colon irrigations, and the Fowler position should constitute the after-treatment. Gall-stones should be removed at the time of the operation, and in draining, it should be borne in mind that the right kidney pouch forms a distinct peritoneal pocket and that a drainage tube applied through a stab opening in the right loin affords a free exit for extravasated fluids coming from the neighborhood of the gall-bladder.

There is great difference of opinion as to the wisdom of performing a cholecystectomy in these perforative cases. Summers (ANNALS OF SURGERY, July, 1911), says: "All infections of the gall-bladder, empyema, gangrene, should be treated by simple incision and drainage after a protective gauze packing of the peritoneal cavity. I have known disaster follow cholecystectomy in such cases—the crushing of the cystic duct and its artery, more especially of the poison laden lymphatics; the trauma to the peritoneum passing from the gall-bladder neck to the gastrohepatic omentum can and does in some instances lead to a thrombophlebitis and fatal infections. By free incision into the gall-bladder, gangrene will probably not extend and tension will be relieved." Robson ("Gall-Stones," 1909, p. 161) regarding perforative cases remarks: "Should marked cholecystitis be found, the question of cholecystectomy may be worth considering; but when the patient is in a critical condition, it is a mistake to attempt too much, and, as a rule, cleansing and free drainage will be all that are necessary or advisable at the time, the removal of the cause being left until the patient is better able to bear a more prolonged operation." Moynihan writes regarding the treatment of perforative cases ("Gall-Stones and their Surgical Treatment," 1905, p. 279): "In all probability cholecystectomy followed by free drainage

Digitized by Google

will prove to be the safest method of treatment." Cotte and Arnaud say (*Revue de Chirurgie,* March, 1911, p. 358): "In all biliary perforations without a concomitant grave infectious state, one can in general content himself with making a simple drainage of the biliary system. In the grave forms, on the contrary, which result from an active process of ulceration or of gangrene, every time that the situation permits it, one should prefer the ablation of the gall-bladder." Mayo, in Keen's "Surgery," vol. iii, says regarding perforations of the gall-bladder: "The treatment should be immediate abdominal section for the removal of the gall-bladder and free drainage."

Conclusions.

1. In 3180 operations on the biliary system, acute spontaneous perforation into the free peritoneal cavity occurred 29 times, or .9 per cent. It is thus a very rare accident.

2. In 90 cases of perforation, 82 of them, or 91 per cent., occurred in the gall-bladder, 3, or 3.3 per cent., perforated through the cystic duct, 4, or 4.4 per cent., through the common duct, while but 1, or 1.1 per cent., perforated through the hepatic duct.

3. Calculi are a great factor in causing perforation, for in 80 out of 108 cases, or 74 per cent., stones were found at the time of the operations. In 14 cases, or 13 per cent., it was found that no stones were present after adequate search. In the 14 remaining cases, or 13 per cent., stones may or may not have been present, as no mention is made of them.

4. In but 9 cases is it distinctly stated that gangrene was present.

5. Of 99 patients whose ages are given, the average was 50 years. Before 50 years, there were 44 cases with 63 per cent. of recoveries, while beyond 50 years there were 55 cases

Digitized by Google

with 46 per cent. of recoveries. Between 50 and 60 years, there were 35 cases with but 14 recoveries.

6. Sixty-two of the cases occurred in women, or 60 per cent., and they stand the disease better than men, the mortality in women being 44 per cent. as against 54 per cent. in men.

7. Of the 108 cases operated upon, 56 recovered, or 51 per cent., while 52 died, or 48 per cent. This is in contrast to the 28 traumatic ruptures, reported by Rickets, operated upon with 22 recoveries, or 78 per cent. The difference is due to infection.

8. Early operation, as in all forms of peritonitis, is the best guaranty of success; thus, of 7 cases operated upon within 12 hours of the perforation 6, or 85 per cent., recovered; of 15 operated upon within one day of the perforation, 10, or 66 per cent. recovered; of 14 within 2 days, 7 recovered, or 50 per cent.; of 16 operated upon within 3 days of the perforation, 8 recovered, or 50 per cent.; while of 10 cases that had gone 4 days before operation only 2 recovered, or 20 per cent.

9. Suture of the perforation is to be unhesitatingly condemned. Four out of 5 cases thus treated died. Simple incision of the abdomen with drainage of the biliary region, gave 47 per cent. of recoveries. With cholecystectomy 48 per cent. recovered. The best results were obtained with cholecystostomy, with which 61 per cent. recovered.

ABSTRACT OF 108 CASES OF BILIARY PERFORATION FROM THE LITERATURE.

CASE I (Von ARX). Female, 48; colics for 2 months, acute for 20 hours; perforation at neck, free bile. Suture of perforation. Cholecystostomy. Recovered. One calculus in gall-bladder.

CASE II (Baldwin). Female, 50; colics for years, symptoms for one day; perforation in body, free bile. Cholecystostomy. Recovered. Six calculi in gall-bladder.

CASE III (Baldwin). Male, 55; indefinite colics four days; perforation in body, gangrene. Cholecystectomy. Died. Several calculi in gall-bladder.

Digitized by Google

CASE IV (Baldwin). Male, 27; symptoms three years, colic two days; perforation in fundus, extensive adhesions. Cholecystectomy. Recovered. Twelve calculi in gall-bladder.

CASE V (Brunner). Female, 56; symptoms one year, colics not stated; perforation of hepatic duct, abdomen full of bile. Tamponade only of abdomen. Died. Stone in ampulla and two in common duct.

CASE VI (Brunner). Female, 50; stomach symptoms 24 hours; gall-bladder perforated, abdomen full of bile. Cholecystectomy. Died. Calculi in gall-bladder.

CASE VII (Czerny). Female, 61; symptoms five days; perforation of gall-bladder, gangrene; abdomen contained bile. Partial cholecystectomy and suture; abdominal drain. Died. Calculi in gall-bladder.

CASE VIII (Delageniere). Perforation of gall-bladder and gangrene. Cholecystectomy. Died. Calculi in gall-bladder.

CASE IX (Finck). Male, 54; symptoms three days; perforation of gall-bladder. Tamponade only. Recovered.

CASE X (Hallet). Female, 45; colics one day; perforation of gall-bladder. Cholecystostomy. Recovered. Four calculi free.

CASE XI (Hallet). Female, 50; colics fifteen hours; pressure perforation at fundus, free bile. Cholecystostomy. Recovered. Numerous calculi in gall-bladder.

CASE XII (Hartig). Female, 42; symptoms four days; perforation of gall-bladder twice, free bile. Cholecystostomy twice. Died. Calculus in gall-bladder. Two operations.

CASE XIII (Hartig). Male, 62; previous colics; perforation of gall-bladder, free bile. Cholecystostomy. Recovered. Perforation over calculus.

CASE XIV (Hartig). Female, 53; symptoms six days; perforation in fundus, adhesions. Cholecystectomy. Died. Three calculi in gall-bladder.

CASE XV (Hirschel). Female, 27; symptoms two days; perforation in fundus, localized. Cholecystostomy. Died. Several great calculi.

CASE XVI (Hirschel). Male, 57; symptoms four days; perforation near neck by pressure. Cholecystostomy. Died. Single calculus; pulmonary gangrene on eleventh day.

CASE XVII (Hirschel). Female, 59; perforation, suture of perforation. Died. Stones not stated; death from pneumonia.

CASE XVIII (Hochenegg). Female, 45; symptoms 12 hours; perforation at middle; suture of perforation. Cholecystostomy. Recovered. Diagnosis, intestinal obstruction; stones present.

CASE XIX (Jaboulay). Male, 66; symptoms two years, colics three days; perforation. Cholecystostomy. Died. One calculus; great.

CASE XX (Jenckel). Female, 45; symptoms three days; perforation at summit. Tamponade only. Died. Stone not stated.

Digitized by Google

CASE XXI (Auvray). Female, 48; symptoms 12 hours; perforation of neck. Suture of perforation. Died. General peritonitis; stones present; no jaundice.

CASE XXII (Kehr). Female, 51; symptoms four days; perforation of common duct. Cholecystectomy. Died. Calculi in common and hepatic ducts; perforation of common duct; jaundice.

CASE XXIII (Konig). Female, 70; symptoms two days; perforation by pressure of gall-bladder. Cholecystectomy. Recovered. Diagnosis, invagination of intestines; calculi numerous.

CASE XXIV (Korte). Male, 56; colics five days; several perforations in gall-bladder. Cholecystostomy. Recovered. Diagnosis, intestinal obstruction; large calculus; intestinal cavity washed.

CASE XXV (Korte). Female, 37; colics three days; several perforations in gall-bladder. Cholecystostomy. Recovered. Calculi present; no jaundice.

CASE XXVI (Korte). Female, 30; colics three days; perforation of gall-bladder. Cholecystectomy. Recovered. Calculi at entrance of cystic duct.

CASE XXVII (Korte). Female, 72; perforation of gall-bladder. Cholecystostomy. Recovered. Several calculi; secondary ectomy two months later.

CASE XXVIII (Korte). Female, 63; symptoms four days; perforation of gall-bladder. Cholecystectomy. Died four week after operation of embolism; one calculus.

CASE XXIX (Korte). Female, 51; perforation of cystic duct; drainage in common duct, also cystic duct. Cholecystostomy. Died. Calculi in common and hepatic duct. None in gall-bladder.

CASE XXX (Korte). Male, 30; symptoms five days. Tamponade, incision only. Died. Stones not mentioned.

CASE XXXI (Korte). Female, 56; symptoms five days; perforation of gall-bladder. Tamponade, incision only. Died on eighteenth day after operation.

CASE XXXII (Kummel-Goldammer). Male, 57; symptoms two days; perforation of fundus, free bile. Cholecystostomy. Died. Calculi present.

CASE XXXIII (Kummel-Goldammer). Female; symptoms three days; free bile. Cholecystostomy. Died. Calculi present; death after a number of days.

CASE XXXIV (Kummel-Goldammer). Female, 33; gangrene with perforation. Cholecystostomy. Recovered. Calculi present.

CASE XXXV (Kummel-Goldammer). Male, 65; gangrene with perforation. Cholecystostomy. Died. Calculi present.

CASE XXXVI (Kummel-Goldammer). Male, 54; gangrene with perforations. Died.

CASE XXXVII (Kummel-Goldammer). Female, 50; symptoms two days; empyema and perforation. Died. Numerous calculi.

Digitized by Google

Case XXXVIII (Kuster). Female, 57; symptoms 28 hours; perforation from pressure of calculi. Closure of perforations. Died. Calculi present.

Case XXXIX (Lecene). Female, 62; symptoms three days; perforation at fundus. Cholecystostomy. Recovered. Single calculus; second operation two months later; cholecystectomy.

Case XL (Maire). Male, 36; symptoms ten days; perforation of gall-bladder, free bile. Cholecystectomy. Died. Icterus present; cholecystitis; calculus in ampulla removed; hepaticus drainage.

Case XLI (Martens). Female, 58; symptoms three days; perforation of cystic duct, gangrene from pressure. Cholecystectomy. Died from pneumonia; calculi present.

Case XLII (Marwedel). Female, 27; symptoms two days; perforation of gall-bladder. Cholecystostomy. Died. Numerous calculi.

Case XLIII (Meriwether). Female, 62; symptoms one day; perforation of gall-bladder by pressure. Cholecystostomy. Recovered. No calculi.

Case XLIV (Meriwether). Male, 80; symptoms five days; perforation of gall-bladder. Tamponade only. Died. Numerous calculi.

Case XLV (Von Mosetig-Moorhof). Male, 59; symptoms four days; perforation of gall-bladder at fundus. Cholecystostomy. Recovered. Several calculi.

Case XLVI (Neck). Female, 43; symptoms three days; perforation of gall-bladder at summit. Cholecystostomy. Recovered. Numerous calculi.

Case XLVII (Newbolt). Female, 48; symptoms two days; perforation of gall-bladder; gangrene; suture of perforation and of abdomen. Died. Stones removed; one impacted in cystic duct. Diagnosis, perforation of gastric ulcer; no jaundice.

Case XLVIII (Nordmann). Female, 49; tamponade only. Recovered. Stones not stated.

Case XLIX (Nordmann). Female, 21; symptoms one day; perforation of gall-bladder, free bile. Cholecystectomy. Recovered. Drainage of common duct; numerous stones; numerous abscesses in gall-bladder wall.

Case L (Riedel). Female, 74; symptoms 36 hours; perforation of fundus. Cholecystectomy. Died. Single large stone in neck.

Case LI (Riedel). Female, 55; symptoms seven days; perforation at fundus. Cholecystectomy. Died. Numerous calculi.

Case LII (Riedel). Male, 56; symptoms three days; perforation of gall-bladder and of common duct. Cholecystostomy. Died. Pigeon's egg calculi in common duct; hepatic drainage, also Douglas.

Case LIII (Routier). Female, 56; symptoms one day; perforation of common duct, free bile. Cholecystostomy. Recovered. Numerous stones, secondary ectomy.

Case LIV (Schnitzler). Female, 55; symptoms five days; perforation of gall-bladder, gangrene. Cholecystectomy. Recovered. One stone; jaundice.

Digitized by Google

Case LV (Schonborn). Female, 50; symptoms three days; abdomen alone drained, free bile. Tamponade of abdomen only. Recovered. No stones found.

Case LVI (Straetter). Female, 63; symptoms five days; perforation of gall-bladder. Cholecystostomy. Recovered. Numerous stones.

Case LVII (Thiel). Female, 59; symptoms three days; perforation of fundus. Cholecystostomy. Recovered. One large stone.

Case LVIII (Torrance). Male, 59; symptoms four hours; perforation of gall-bladder, free bile. Cholecystectomy. Recovered. Gastro-enterostomy, appendectomy; stones not stated.

Case LVIX (Ullmann). Male, 42; symptoms six days; perforation from pressure of stone in gall-bladder. Cholecystectomy. Died. Numerous calculi, one in cystic duct; no jaundice.

Case LX (Ullmann). Female, 53; symptoms twelve hours; perforation of gall-bladder, free bile. Tamponade only. Recovered. Numerous stones; no jaundice.

Case LXI (Verral). Female, 44; symptoms four days; perforation of fundus; suture of gall-bladder. Recovered. Numerous calculi.

Case LXII (Villard). Female, 35; symptoms three days; perforation of gall-bladder. Tamponade only. Died. Numerous calculi.

Case LXIII (Weigel). Male, 45; symptoms one day; perforation of fundus, free bile. Cholecystostomy. Died. Calculi removed from cystic duct and gall-bladder.

Case LXIV (MacLaren, Case III). Male, 50; symptoms ten days; perforation on anterior wall. Cholesystostomy. Recovered. No stones.

Case LXV (Vaughan). Male; symptoms three days; perforation of gall-bladder; drainage of abdomen only. Died. No stones; developed during typhoid and operation for supposed perforation.

Case LXVI (Rixford). Male, symptoms two days; perforation at fundus. Cholecystectomy. Recovered. Aseptic perforation; numerous calculi in gall-bladder.

Case LXVII (Haggard). Male; perforation of gall-bladder. Drainage of abdomen only. Recovered. Stones free in abdomen.

Case LXVIII (Moynihan). Male, 46; symptoms eleven days; perforation at fundus, free bile. Cholecystostomy. Died. Seven stones in gall-bladder.

Case LXIX (Walker). Male, 27; symptoms three days; perforation at fundus by pressure, free bile. Cholecystostomy. Recovered. Numerous stones; one large one by pressure caused perforation.

Case LXX (Maclaren, Case VIII). Male, 45; symptoms two weeks; perforation at fundus; enormous abscess with bile. Cholecystostomy. Recovered. Stones removed at secondary operation; subdiaphragmatic abscess opened; jaundice present.

Case LXXI (MacLaren, Case IX). Female, 31; symptoms ten days; perforation at fundus; large abscess and stones. Tamponade only. Recovered. Jaundice.

Digitized by Google

CASE LXXII (MacLaren, Case X). Female, 32; large abscess with stones. Cholecystostomy. Recovered. Followed on typhoid; secondary cholecystostomy with removal of stones.

CASE LXXIII (Ferguson). Female, 35; perforation at fundus, free bile. Cholecystostomy. Recovered. Several stones; jaundiced.

CASE LXXIV (Noetzel). Male, 52; Cholecystectomy. Died. Stones not stated.

CASE LXXV (Noetzel). Male, 63; Cholecystectomy. Died. Stones not stated.

CASE LXXVI (Noetzel). Female, 62; Cholecystectomy. Died. Stones not stated.

CASE LXXVII (Noetzel). Female, 65; Cholecystectomy. Recovered. Stones present.

CASE LXXVIII (Noetzel). Female, 59; Cholecystectomy. Died. Stones not stated.

CASE LXXIX (Noetzel). Female, 23; Cholecystectomy. Recovered. Single stone present.

CASE LXXX (Narath). Male, 59; symptoms four days; perforation of gangrenous spot, free bile. Cholecystostomy. Died from pulmonary gangrene. One stone in gall-bladder.

CASE LXXXI (Kranze). Age 67; symptoms two days; perforation at fundus, free bile. Cholecystostomy. Recovered. Diagnosis before operation, volvulus; no stones.

CASE LXXXII (Kranze). Age 70; symptoms six days; perforation at neck, free bile. Cholecystostomy. Recovered. No stones.

CASE LXXXIII (Neupert). Female, 42; symptoms fourteen hours; perforation of common duct at juncture with cystic duct, free bile. Cholecystectomy. Recovered. Jaundice; acute impaction of stone in common duct. Removed.

CASE LXXXIV (Whitacre). Male, 72; symptoms twelve hours; no stones; perforation of gall-bladder, free bile. Cholecystostomy. Recovered. No stones; no jaundice.

CASE LXXXV (Whitacre). Female, 42; symptoms one week; fundus perforated, free bile. Cholecystostomy. Recovered. Many stones in gall-bladder; no jaundice.

CASE LXXXVI (Whitacre). Female, 26; first operation 24 hours, second operation 27 hours; perforation in fundus, free bile. Tamponade only in both operations. Recovered. Three operations; two first were cholecystostomies, third was cholecystectomy; two perforations at different times; gall-stones present in gall-bladder; jaundice not mentioned.

CASE LXXXVII (Whitacre). Male, 58; symptoms two days; perforation in fundus, free bile. Cholecystostomy. Recovered. Stones in gall-bladder; no jaundice.

Digitized by Google

CASE LXXXVIII (Whitacre). Female, 50; symptoms one day; free bile. Tamponade only. Died. Stones not stated; no jaundice.

CASE LXXXIX (Whitacre). Female, 28; symptoms several days; free bile. Tamponade only. Recovered. Stones not stated; no jaundice.

CASE XC (Kiliani). Male, 40; symptoms four weeks; two perforations in fundus. Cholecystectomy. Died. Two small perforations of ileum found; two stones present.

CASE XCI (McWilliams). Male, 67; symptoms one day; perforation in fundus, immense pocket of bile. Cholecystostomy. Recovered. Diagnosis, intestinal obstruction or appendicitis; two incisions; no jaundice; stone removed.

CASE XCII (McWilliams). Male, 38; symptoms three days; perforation of cystic duct. Cholecystostomy. Died. Diagnosis, appendicitis; two incisions; stone present.

CASE XCIII (Dr. Brown). Male, 49; symptoms two weeks; perforation at fundus. Cholecystostomy. Recovered. One stone removed.

CASE XCIV (Dr. Blake). Male, 49; symptoms two days; perforation at fundus, no adhesions, free pus. Cholecystectomy. Recovered. Many stones; general abdominal irrigation.

CASE XCV (Dr. Hawkes). Male, 31; symptoms four days; large abscess, adhesions. Tamponade only. Died twenty-one days after operation. No stones; jaundice present.

CASE XCVI (Dr. McCosh). Male, 26; adhesions about gall-bladder; gangrene, bile and pus. Cholecystectomy. Recovered. No stones; jaundice present.

CASE XCVII (Roersch). Female, 67; symptoms one day; perforation of gall-bladder, free bile. Cholecystostomy. Died. Operation for intestinal obstruction; single stone present.

CASE XCVIII (Erdmann). Female, 46; symptoms twelve hours; perforation of gall-bladder, free bile. Cholecystostomy. Recovered. Diagnosis, intestinal perforation; stones present in gall-bladder; typhoid present.

CASE XCIX (Jopson). Female, 51; symptoms 72 hours; perforations not located, free bile. Cholecystostomy. Recovered. Stone impacted in cystic duct; jaundice present.

CASE C (Fritz-Koenig). Female, 70; symptoms two days; perforation at fundus. Cholecystectomy. Recovered. Numerous stones; jaundice.

CASE CI (Williams and Sheidd). Male, 31; perforation of gall-bladder. Tamponade only. Recovered. During typhoid no stones.

CASE CII (Adâm). Female; perforation of gall-bladder. Cholecystostomy. Died. Stones not mentioned.

CASE CIII (Adâm). Cholecystostomy. Died. Stones not mentioned; jaundice present.

CASE CIV (Adâm). Cholecystostomy. Died. Stones not present; jaundice present.

Digitized by Google

CASE CV (Mayo-Robson). Male, 45; several pints of bile and pus. Cholecystostomy. Recovered. Stones not mentioned.

CASE CVI (Mayo-Robson). Female, 47; symptoms six days; perforation of fundus. Cholecystectomy. Recovered. Several stones removed; deeply jaundiced.

CASE CVII (Gordon). Male, 50; symptoms four days. Tamponade only. Died. Calculi present; jaundice present.

CASE CVIII (Grant). Male, 53; symptoms fifteen hours; quart of bile. Tamponade only. Died. Diagnosis, appendicitis; no stones; no jaundice.

LITERATURE.

Von Arx: Korrespondenz Platt fur Schweizer Aertze, 1902, Nos. 19 and 20.

Baldwin: In Moynihan, Gall Stones, 1905.

Brunner: Korrespondenz fur Schweizer Aertze, 1909, 39, No. 9, Observ. 23.

Czerny: Beitrage zur klin. Chir., 1902, Supp. p. 23, and 143.

Delageniere: Archiv. provinciales de Chir., July 7, 1910, p. 387.

Erdmann. ANNALS OF SURGERY, June, 1903.

Finck: Prager med. Wochen., 1907, p. 665.

Hallet: Revue de Gynec. et de Chir., abdom., 1904, p. 821.

Hartig: Beitrage zur klin. Chir., 1910, Vol. LXVIII.

Hirschel: *Ibid*, 1907, Vol. LVI, p. 272.

Hirschel: Münchener med. Wochensch., 1910, No. 15.

Hochenegg: Wiener klin. Wochensch., 1899, No. 21, p. 565.

Jaboulay: Lyon Medical, 1903, II, p. 826.

Jenckel: Deutsche Zeit. fur Chir., 1909, Vol. CII, p. 337, Obs. 7.

Kehr: Arch. fur klin. Chir., 1909, Vol. LXXXIX, p. 152.

Konig: Deutsche med. Wochensch., 1902, No. 7.

Korte: Beitrag zur Chir. der Gallenwege, Berlin, 1905.

Korte: Archiv. fur klin. Chir., 1909, Vol. LXXXIX, p. 32.

Kummel: In Goldammer, Beitrage zur klin. Chir., 1907, Vol. LV, p. 58.

Kuster: Deutsche Gesellschaft f. Chir., 1897.

Lecene: Revue de Chir., March, 1911, p. 369.

Maire: Congres Francais de Chir., 1907, p. 308, Obs. 2.

Martens: Presse medicale, 1909, July 31, p. 549.

Marwedal: Mittellung. der Grenzegeb. d. Med. und Chir., 1902, IX, p. 582.

Meriwether: New York Medical Journal, 1910, Vol. XCI, p. 337, Obs. 1.

Von Mosetig-Moorhof: Wiener med. Presse, 1902, Feb. 16, p. 306.

Narath: Jahresbericht der Heidelbergen chir. Klinik, 1906, also Beitrage, 1907.

Newbolt: Lancet, 1902, May 31, Vol. L, p. 1534.

Noetzel: Verhandlungen der deutschen Gesell. f. Chir., 1909, p. 701.

Nordmann: *Ibid.*, Vol. II, p. 216.

Digitized by Google

Riedel: *Ibid.*, Vol. II, p. 216.
Roersch: Annales de la Soc. med. chir. de Liege, 1904, No. 2.
Routier: Soc. de chir. de Paris, 1909, p. 1311.
Schnitzler: Münch. med. Wochensch., 1903, No. 19.
Schonborn: In Naunyn. Klinik der Cholethiasis, p. 83.
Straetter: Deuxieme Congres internat. de Chir., 1908, p. 103, Obs. 1.
Thiel: Centralblatt fur Chir., 1904, No. 10.
Torrance: Boston Med. and Surg. Jour., July 30, 1908, No. 5, p. 144.
Ullmann: Wiener med. Wochensch., 1899, Nos. 25 and 26.
Verrall: Brit. Med. Rep., 1897, August 7.
Villard: *Ibid.*
Weigel: Deutsche Zeitsch. fur Chir., 1903, Aug. 23, p. 71.
Whitacre: Ohio State Med. Jour., May, 1911.
Cotte et Arnaud: Rev. de Chir., March, 1911.
Rickets: St. Louis Med. Review, 1905, pp. 108, 233, 276, 456, 476, 497.
Fritz Koenig: Deutsche med. Wochen, 1902, No. 7, p. 110.
Mayo-Robson: Diseases of the Gall-Bladder, 1909.
Williams and Sheidd: Lancet, March 2, 1895.
Auvray: Bull. de la Soc. anat. de Paris, 1899, p. 771.
Grant: Jour. Amer. Med. Assoc., April 18, 1903, p. 1057.
Gordon: Brooklyn Med. Jour., April, 1903.
Kranze: Zentralbl. f. Chir., 1900, No. 13, p. 469.
Neupert: *Ibid.*, 1910, No. 20, p. 712.
Schievelbein: Beitrage z. klin. Chir., 1911, Vol. LXXI, p. 570.
Clairmont: Mittel. a. d. Grenzegeb. d. Med. u. Chir., 1910, Vol. XXII, p. 154.
Finsterer: Deutsche Zeit. f. Chir., August, 1911, p. 211.
MacLaren: Trans. Amer. Surg. Assoc., 1905, Vol. XXIII, p. 207.
Vaughan: *Ibid.*, p. 216.
Richardson: *Ibid.*, p. 217.
Rixford: *Ibid.*, p. 219.
Walker: *Ibid.*, p. 306.
Moynihan: Gall-stones and their Surgical Treatment, 1905.
Adám: Pest. med. chir. Presse, 1910, Nos. 13 and 14.
Blake: Annals of Surgery, 1903, Vol. XXXVII, p. 935.
Kiliani: *Ibid.*, 1907, Vol. XLV, p. 34.
MacCarthy: *Ibid.*, 1910, Vol. LI, p. 657.
Hildebrandt: Archiv. f. kl. Chir., 1906, Vol. LXXXI, p. 646.

Digitized by Google

Digitized by Google

XXII.

ON THE LESIONS PRODUCED IN THE APPENDIX BY OXYURIS VERMICULARIS AND TRICHOCEPHALUS TRICHIURA.*

By Russell L. Cecil, M.D., Assistant Visiting Physician,
and
Kenneth Bulkley, M.D., Lately House Surgeon.

The importance of intestinal parasites as the exciting cause of appendicitis was first emphasized in 1901 by Metchnikoff,[1] who reported three cases of this disease due to *Ascaris lumbricoides*. Metchnikoff's contributions served to awaken some interest among clinicians in parasitic appendicitis, but the subject is one which, on the whole, has received very meager scientific study.

The commonest parasitic inhabitant of the appendix is *Oxyuris vermicularis*. Brumpt[2] found pin-worms in the appendix in 3.5 per cent. of normal cases, and in 40 per cent. of all cases of appendicitis.

Railliet's[3] figures are still higher for the same locality (Paris). He found oxyuris in 58 out of 119 cases of appendicitis examined, or 48 per cent. Hoepfi[4] found them less common in Germany, but even there he could demonstrate them in the appendix of 21 per cent. of all cases of appendicitis. In London, Still[5] found oxyuris in 19 per cent. of all normal children's appendices examined at autopsy. *Trichocephalus trichiura* probably ranks second in importance, but is much less frequently found. Brumpt and Lecene[6] found Trichocephalus in 4 per cent. of normal adult appendices. Railliet, however, in 119 cases of appendicitis, encountered trichocephalus only once. Delsmitt[7] and Oelnitz[8] found that a large percentage of diseased appendices contained the ova of trichocephalus.

(*Reprinted from the Journal of Experimental Medicine, March, 1912.)

(*From the Pathological Laboratory of the Presbyterian Hospital, New York, and the Surgical Research Fund of Columbia University.*)

Digitized by Google

In America, the incidence of these two parasites in the appendix has not been studied. Erdman[9] noted the presence of pin-worms in 4 out of 250 cases of appendicitis in children, but it is probable that a thorough examination of the contents of the appendix under the microscope would have shown a much higher percentage.

As far as the pathology of oxyuris and trichocephalus appendicitis is concerned, it may be said that the greater part of the literature on the subject consists of clinical reports of single cases, in many of which there is no reference whatever to the pathological changes found. It is unnecessary to cite these cases.

Several writers (Wakefield[10], Wagener[11], and Walther[13]) have noted that the parasites were attached to the mucous membrane, but they give no descriptions of the gross or microscopic lesions produced. On the other hand, a number of case reports, such as those of Culhane[12], Martin[14], Von Moty[15], Pabeuf and DuBois[16], Ashhurst[17], and Bégouin[18], contain descriptions of the histological changes found, such as superficial ulceration of the mucosa and swelling of the lymph follicles, but they fail to establish a relationship between the parasites and the changes described.

Winkler,[19], Hippius and Lewinson[20], Weinberg[21], Romanovitch[23], Brumpt and Lecene[6], and Galli-Valerio[22] have all reported single cases of oxyuris appendicitis in which the parasite is shown to be the actual cause of the disease. The description in nearly every case is identical. At operation, the appendix was lying free and moderately swollen and injected. On opening the appendix, one or more parasites were found attached to the mucous membrane, which was swollen and often marked by small ecchymoses. Microscopical sections showed the worms burrowing under the mucous membrane and invading the lymph follicles. Brumpt and Lecene observed small hemorrhages about the invading parasites. Galli-Valerio's case was that of a gangrenous oxyuris appendicitis in a boy five years old. The mucous membrane showed a number of necrotic foci surrounded by zones of inflammation. In some of these foci, male oxyurides were found. The author concludes that in this case, the parasite acted as a predisposing factor, the bacteria gaining entrance through the break produced by the oxyuris. The case reported by Romanovitch is of the same charcter.

Unterberger[24] has reported two cases of oxyuris appendicitis, accidentally discovered at autopsy, in both of which he found the parasite invading the mucous membrane. Railliet has recently made a study of 58 appendices that contained oxyurides. While he refers to the fact that oxyuris sometimes attacks the mucous membrane, his study is almost entirely a biological one,

Digitized by Google

dealing with the incidence of oxyuris appendicitis, number of parasites and proportion of each sex present, and their blood-sucking faculty.

In spite of the statement of Wichman[35], that trichocephalus never penetrates the intestinal mucosa, Girard[36] and Weinberg[21] have each reported a case of appendicitis in which the trichocephalus was found attached to the mucosa of the appendix. Girard's case was in a child eight years old. The appendix appeared normal externally. On the mucosa, however, two trichocephali were found, attached by their anterior extremities to the mucous membrane. Microscopically, there were no inflammatory changes except about the heads of the parasites, where an infiltration of leukocytes had occurred, and streptococci and Gram-negative bacilli were present. Weinberg's case is very similar. None of the coats of the appendix showed any changes except the mucosa, which at one point had been invaded superficially by a trichocephalus. In Weinberg's case, there was no inflammatory reaction about the parasite, nor were any bacteria demonstrated in the tissue.

From this brief but fairly comprehensive review of the literature, it is apparent that there has been very little systematic study of the pathology of oxyuris and trichocephalus appendicitis, and slight effort to determine whether the presence of parasites in a diseased appendix is fortuitous, a predisposing factor, or the exciting cause of the disease.

The present report is based on a study of 148 unselected appendices of children between the ages of two and fifteen. We have also included four adult cases of oxyuris appendicitis. In this investigation, we have undertaken to determine:

(1) The incidence of oxyuris and trichocephalus in the normal appendices of children.

(2) The incidence of oxyuris and trichocephalus in the appendicitis of children.

(3) The percentage of appendices containing these parasites in which specific lesions produced by them could be demonstrated.

(4) The character of such lesions.

The material has been collected in large part from the two surgical services of the Presbyterian Hospital. The remainder,

Digitized by Google

with the exception of one case, has come from other New York hospitals.

Of the 148 children's appendices examined, 19 were normal and served as controls. They were all removed at autopsy from children who had died of various diseases. In three of the nineteen oxyuris was present. Trichocephalus was not found in any of this series.

The remaining 129 appendices were all from operative cases, and all of them showed pathological changes. Of this series, nineteen or about fifteen per cent. contained parasites, the oxyuris in seventeen, and the trichocephalus in two cases.

Our cases may be classified as follows:

	Oxyuris	Trichocephalus	No parasites	Total
1. Acute catarrhal appendicitis—				
Children	14	1	5	20
Adults	4	0	0	4
2. Chronic appendicitis	0	0	20	20
3. Acute suppurative appendicitis	0	0	25	25
4. Acute gangrenous appendicitis	3	1	60	64
5. Normal appendices	3	0	16	19
	24	2	126	152

Methods of Study.

In most cases, we have examined the appendix in the fresh state. The condition of the serosa having been noted, the appendix was carefully opened with small probe-pointed scissors, and the contents inspected with a hand lens. If parasites were seen, one or two of them were carefully removed, placed on a glass slide in a drop of normal salt solution, and examined under the low power of the microscope. The characteristic shape and structure of the oxyuris and trichocephalus made the identification easy. Sections for miscroscopical study were taken

Digitized by Google

at the site of the worm or through ulcerated areas. If parasites were not seen, the mucosa of the appendix was washed off with normal salt solution, the suspension centrifuged, and the sediment examined under the low power of the microscope. In this way we were able, in several instances, to demonstrate the presence of oxyuris, where it would have otherwise escaped detection. In every case, the tissue was imbedded in paraffin, serial sections cut, and stained with hematoxylin and eosin.

Oxyuris Appendicitis.

In the classification of cases given above, it will be observed that of the twenty-one cases of appendicitis associated with oxyuris, eighteen were of the acute catarrhal, and three of the acute gangrenous type. We have noted the same predominance of the catarrhal type in the cases reported in the literature. Our own cases have presented in the gross a remarkably similar appearance. Excepting the three gangrenous cases, which contained nothing characteristic, they have shown the following changes: The appendix is moderately swollen and rigid, but the serosa is smooth, pale, and glistening. The vessels of the serosa may be congested. On opening the appendix, the lumen is usually found to be filled with blood and mucus, in which can be seen writhing one or more parasites. The male oxyuris is hard to see with the naked eye. In our series, the number of worms present has varied from one to thirty-five. In eight cases the males have outnumbered the females, and in eight the females outnumbered the males. In the remaining five cases, the two sexes were equally represented. The mucosa is invariably swollen, pale pink in color, and appears more velvety than normally. In most cases, it is marked here and there, usually in the neighborhood of a parasite, by dark red purpuric spots, or small hemorrhagic ulcers. There is no evidence of suppura-

Digitized by Google

tion, gangrene, or perforation. In several of our cases, we have seen pin-worms firmly attached to the mucous membrane. In two cases, living worms were seen to free themselves from the mucosa while under observation. It is of course with the microscopical changes that we have been most concerned. It will be convenient to classify the cases according to the lesions found.

1. There is the group where pin-worms, though present in the appendix, have apparently produced no lesion other than a mild catarrhal appendicitis. In the gross, the appendix is thickened and rigid and its mucosa is swollen, but the focal hemorrhages on the mucosa are absent, and no worms are seen adherent to it. Microscopically, the crypts of the mucous membrane are filled with mucus, and the keim centers of the lymph follicles are considerably enlarged. The submucosa and muscularis may show no changes. The serosa is usually normal, but it may be slightly thickened, especially in the case of adults. In some cases a few scattered polymorphonuclear leukocytes, eosinophiles, and lymphoid cells have been noted in the muscularis and serosa.

In our series of seventeen cases of oxyuris appendicitis in children, we have encountered only three such cases (cases 8, 14, and 20). The four cases of oxyuris appendicitis in adults also belong to this group, though two of them also showed mild chronic changes. In all seven of these cases we have cut serials from various parts of the appendix, but with negative results as far as specific lesions are concerned.

2. In the second group, we may include those cases in which the oxyuris has punctured or invaded the mucosa, but where there has been little or no destruction of tissue. By some means or other, the parasite, usually the male, breaks through the columnar epithelium, and burrows into a lymph follicle.

Digitized by Google

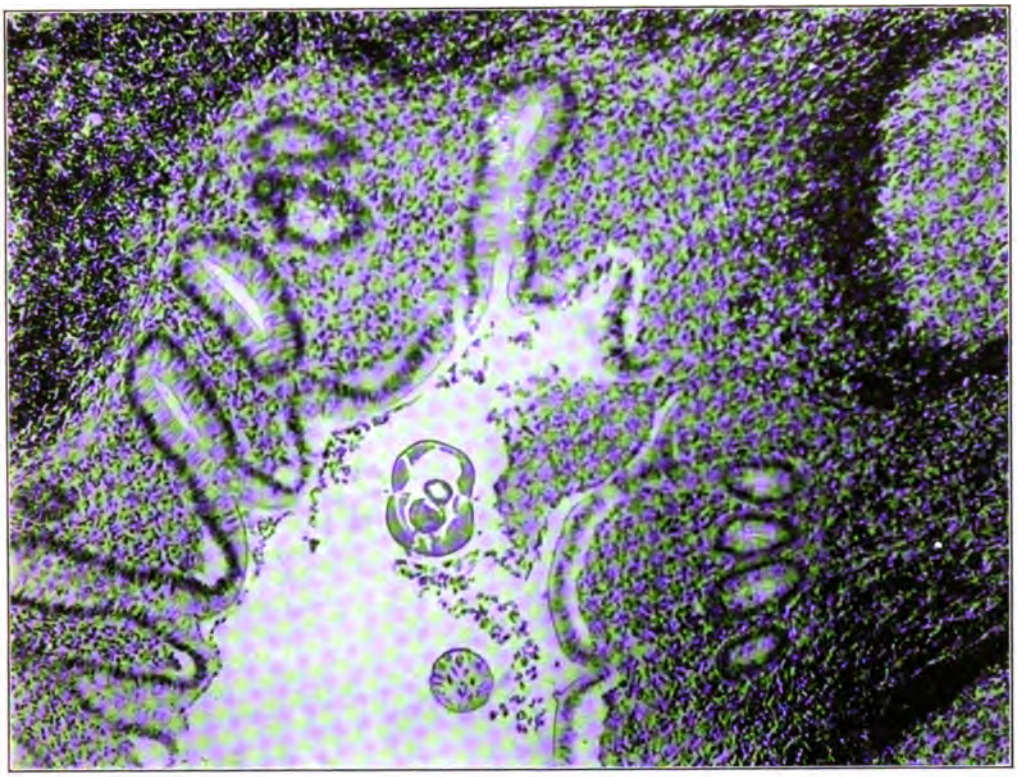


Fig. 1

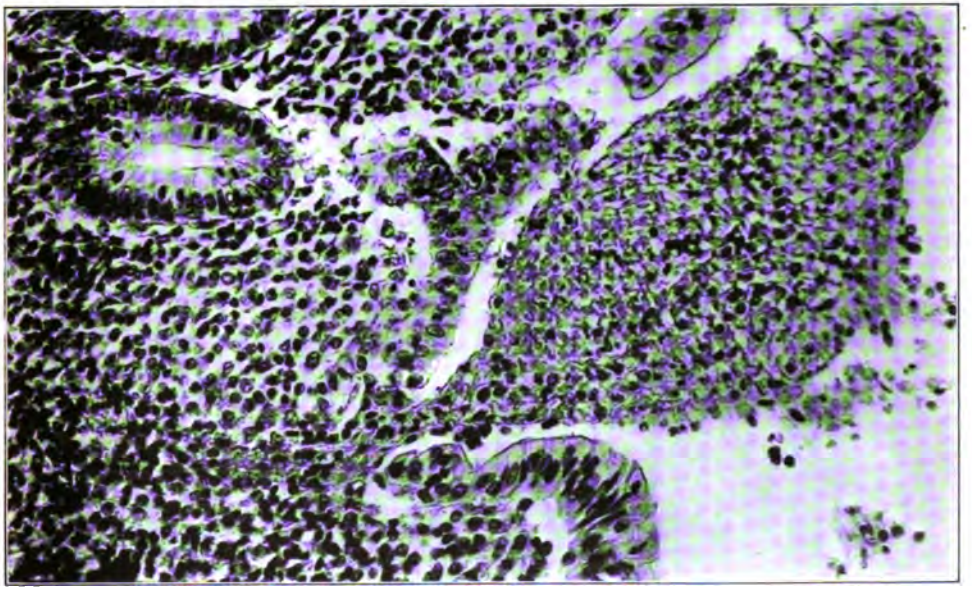


Fig. 2

Digitized by Google

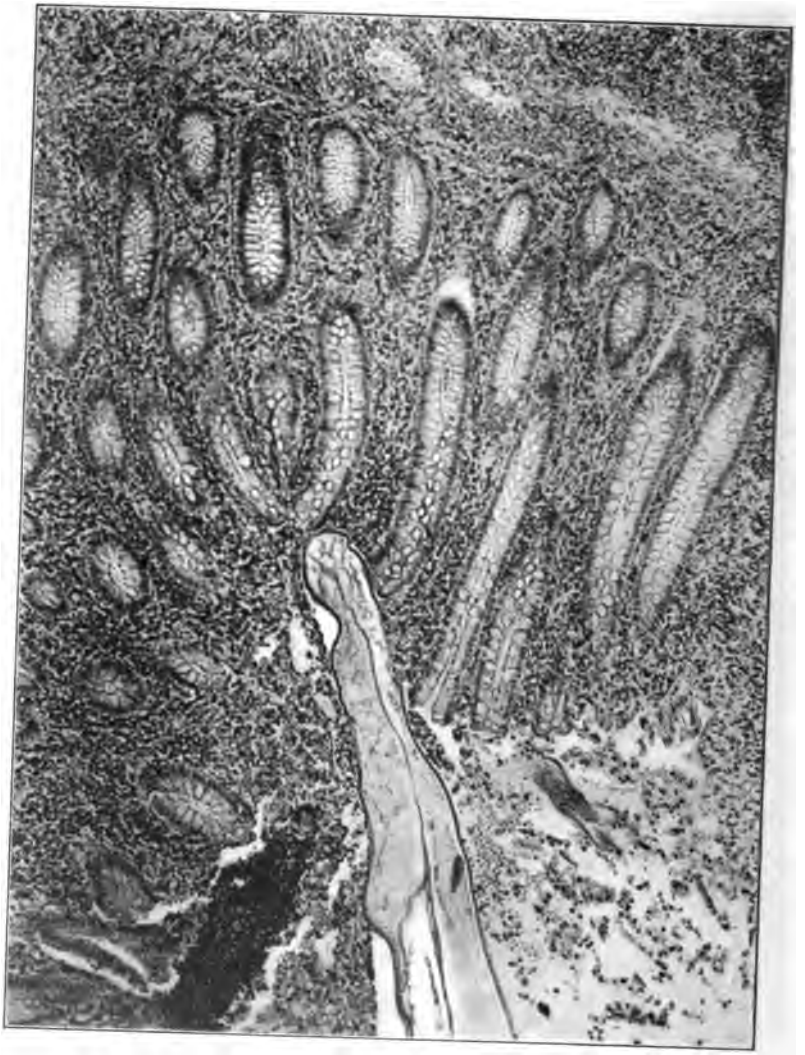


FIG. 3.

Digitized by Google

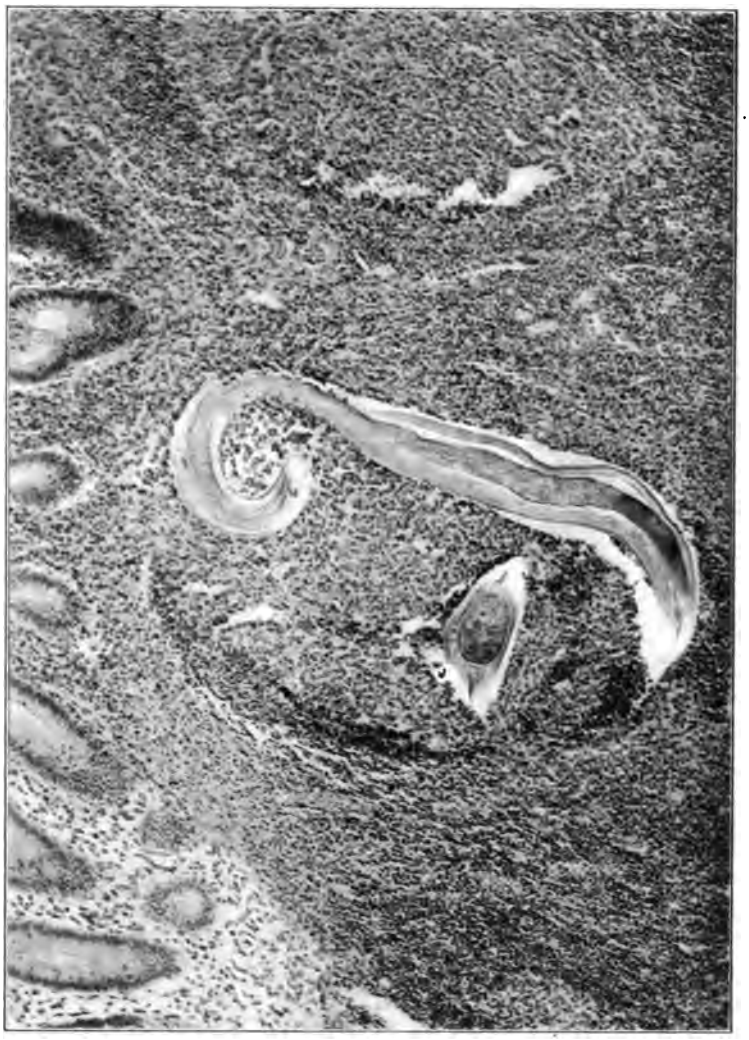


FIG. 4.

Digitized by Google

FIG. 5.

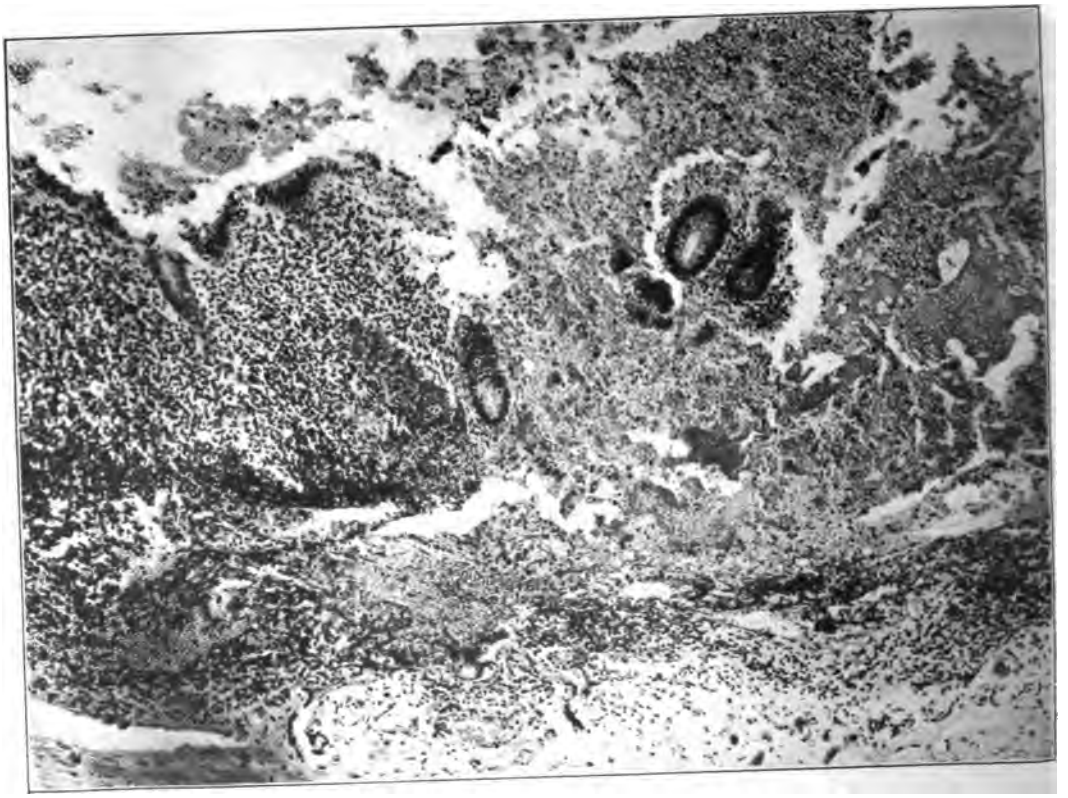


FIG. 6.

Digitized by Google

Such lesions may be recognized in the gross as small purpuric spots, over which the mucosa often appears intact.

Microscopically, there is extensive extravasation of blood into the tissue and out through the ruptured epithelium into the lumen, but with it all no evidence of an inflammatory reaction. In those cases where the worm has penetrated into a follicle, a slender trail of necrotic tissue may be traced back through the serial sections to a small break in the columnar epithelium, but there is no infiltration of leukocytes about it. In Case 2, there was considerable necrosis and infiltration of leukocytes about one of the parasites found in a follicle. Bacteria were, however, demonstrated in the necrotic tissue. Six of our cases belong to this group (cases 2, 3, 4, 7, 19, and 21). Beautiful examples of the puncture wound of the mucosa were demonstrated in cases 4, 7, and 21 [Figs. 1, 2 and 3] while in cases 2, 3, and 19, parasites were actually found in the lymph follicles. [Fig. 4.]

3. In this group we have placed the cases showing destructive oxyuris lesions. In these, there is seen more or less necrosis of the mucosa, with the formation of ulcers, which are characterized by (*a*) hemorrhagic bases; (*b*) undermined edges; (*c*) absence of inflammatory reaction about them.

The ulcers are dark red in the gross and rather shallow. Microscopically the submucosa forms the base of the ulcer which is covered with blood and necrotic tissue [Fig. 6]. The edges of the ulcer are undermined, sometimes markedly so, when the pin-worm burrows beneath the mucosa into neighboring follicles [Fig. 5]. In two cases (cases 1 and 9), the mucosa had been, in places, almost entirely separated from the submucosa by the extensive tunneling beneath it. About neither the ulcer nor the sinuses connected with it, have we ever seen the slightest inflammation. Five of our cases belong

Digitized by Google

to this group (cases 1, 5, 9, 10, and 17). In cases 1 and 9 oxyurides were demonstrated in the ulcers.

4. The fourth group comprises the cases of gangrenous appendicitis, associated with oxyuris. Three of our cases have been of this type (cases 11, 12, and 13). In case 12, there was a perforation. Except for the presence of pin-worms in the lumen of the appendix these three cases differed in no respect from the usual type of gangrenous appendicitis. No specific oxyuris lesions were found in this group though several serials were cut from each case.

In cases 2 and 5, we found, in addition to the lesions already described, foci where the process of repair was going on. In case 5, the ulcer was still present, but reduced to a small slit, which was surrounded by granulation tissue. In case 2, we found deep in the mucosa a remarkable healed lesion, consisting of a hyaline oxyuris surrounded by a few fibroblasts, and the whole enclosed in a thick capsule of dense fibrous tissue [Fig. 7].

Autopsy Cases.—Oxyuris was found in three children's appendices that were removed at autopsy. These serve as controls for the clinical cases, and were studied in exactly the same way, even to the cutting of serial sections. All three appendices appeared normal in the gross. It was noticed that the lumen in these cases contained yellow feces, instead of the blood and mucus seen in the pathological cases. In no instance were the parasites attached to the mucous membrane. Microscopically, serials failed to reveal any punctures or ulcerations of the mucosa. The lymph follicles, however, showed well marked swelling of the keim centers. The other coats of the appendix were normal.

Digitized by Google

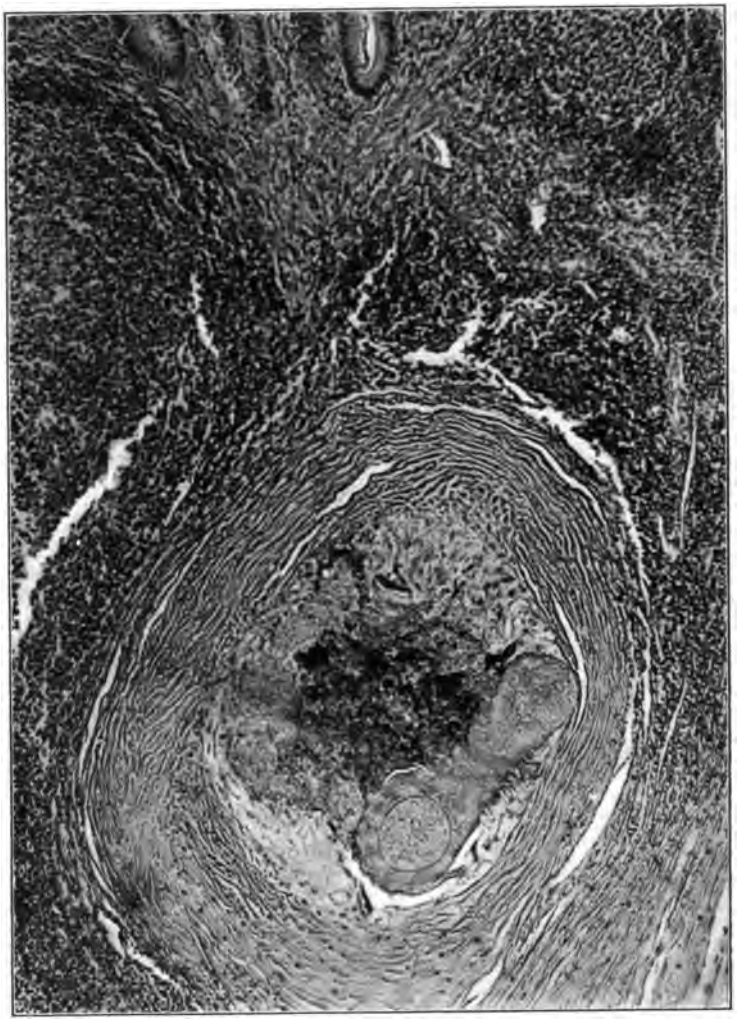


FIG. 7.

Digitized by Google

FIG. 8.

Digitized by Google

Trichocephalus Appendicitis.

Our series includes only two cases of trichocephalus appendicitis, one catarrhal, the other gangrenous. The former (case 23) had, macroscopically, many of the traits of an oxyuris appendix. It was swollen and moderately congested. The mucosa was swollen, but smooth and pale. Near the base, a single whip-worm was found, firmly attached by its head to the mucosa. Microscopically, the parasite is seen burrowing along just beneath the columnar epithelium, and, like the oxyuris, producing absolutely no inflammatory reaction [Fig. 8]. The epithelium just over the parasite has become stretched and thinned, and has lost entirely its normal structure, appearing more like an extra coat to the worm than like columnar epithelium. There are no changes in the other coats of the appendix. In the gangrenous case (case 22), the trichocephalus was attached to the mucosa, just proximal to the gangrenous portion, the tissue immediately about the parasite being sound. Microscopical sections show the parasite burrowing along beneath the epithelium in precisely the same manner observed in the catarrhal case. There was no evidence of parasite invasion in the gangrenous portion.

Discussion.

If the series of normal appendices be compared with that of pathological appendices, it will be observed that about the same proportion of both series (15 per cent.) contained parasites. Unfortunately, the series of control cases is so small that no definite conclusions can be drawn from it. Schloss (27) has recently investigated the incidence of intestinal parasites in healthy children on the east side of New York City, and found the oxyuris present in 7 per cent. Such a percentage, or even a smaller one, would probably represent the incidence of oxy-

Digitized by Google

uris in the normal appendix of children, and would more nearly agree with the figures of Still already quoted.

In considering the first group of oxyuris cases, that is, the several cases in which there was no evidence of invasion of the mucosa by the parasites, the question will naturally arise whether the worms were in any way responsible for the slight pathological changes found, for on the one hand, five out of the 152 appendices studied were cases of catarrhal appendicitis without worms, and on the other, three normal appendices, removed at autopsy, contained worms. We believe, however, that the parasites did cause the symptoms and tissue changes observed. In the first place, it is quite possible that minute puncture wounds were overlooked. It was obviously impossible to cut a serial of the entire appendix, and only in that way could the possibility of such an oversight be excluded. The hyperplasia of the lymph follicles even in the control cases suggests that the mere presence of the oxyuris in the appendix is a source of irritation to the organ, and in the absence of other etiological factors, such as kinks, strictures, foreign bodies, and bacterial infection, it is rational to suppose that the parasites were themselves the exciting agent.

It is interesting to note that all four of the cases occurring in adults belonged to this class. This may be nothing more than a coincidence, but it is possible that the appendix, after having been for years infested with the oxyuris, acquires some immunity against the parasite. At any rate, the majority (70 per cent.) of the cases of oxyuris appendicitis in children fall into the second and third groups, in which actual injury to the mucosa is wrought by the parasites. Whether it be a slight puncture, or penetration into a lymph follicle, or extensive ulceration of the mucous membrane, the fact remains that the oxyuris has produced definite and characteristic lesions in the

Digitized by Google

appendix, and that usually these are the only noteworthy changes found. The absence of inflammatory reaction about the oxyuris lesions, even in those cases where there has been extensive ulceration, has been noted by various observers in connection with other parasites. The reason for this phenomenon is not at hand, but the most probable explanation is one that would attribute it to some kind of negative chemotaxis. In this connection, it has occurred to us as remarkable that secondary bacterial infections have not oftener been associated with the oxyuris lesions. We have demonstrated such an association in only one case (case 2), but the three cases of gangrenous appendicitis may also be instances of it. The extensive gangrene present in these cases might readily have blotted out all traces of any oxyuris lesions, had they been present. We have been impressed with the rarity of healed oxyuris lesions, and have concluded that the puncture wound can probably heal without the formation of scar tissue. The encapsulated focus described in case 2 was associated with necrotic foci surrounded by leukocytes and containing bacteria. One would expect such lesions in healing to pass through the usual phases of inflammation and repair. Lesions, however, which are entirely free from inflammatory changes, might be repaired without any visible evidence of such repair having taken place. The apparently healing ulcer in case 5 had been reduced to a vertical slit, surrounded by vascular connective tissue, and no doubt would have eventually become a path of dense fibrous tissue.

In respect to trichocephalus appendicitis, it would be impossible to draw many conclusions from a study of only two cases. From a comparison, however, of our cases with those reported by Girard and Weinberg, it is quite probable that in trichocephalus, as in oxyuris, appendicitis, the lesions are con-

Digitized by Google

fined exclusively to the mucosa. There is the same swelling of the lymph follicles, and invasion of the mucosa by the parasites. The most noticeable difference between the invasion of the oxyuris and that of the trichocephalus is that the oxyuris penetrates deeply into the mucosa and usually enters a lymph follicle, while the trichocephalus burrows along just beneath the columnar epithelium. In case 22 of our series, it is impossible to say whether the trichocephalus was implicated in the grangrenous changes at the tip of the appendix, or whether the two lesions were entirely independent of each other. The inference is that the slight lesions produced by the parasite opened the way for bacteria and the onset of gangrenous appendicitis.

In two cases out of the entire series, we have found only the ova of parasites in the contents of the appendix, once the eggs of oxyuris, once those of trichocephalus. These cases could, of course, not be included in the cases of parasitic appendicitis, but there remained the suspicion that parasites might have been concerned in the changes noted. Both cases were of the gangrenous type.

Summary and Conclusions.

1. In a study of 129 cases of appendicitis in children, we have found that in nineteen of them (15 per cent.) the appendix contained *Oxyuris vermicularis* or *Trichocephalus trichiura*.

2. The oxyuris is much the commoner of the two parasites, occurring seventeen times, while the trichocephalus was found only twice.

3. In fifteen out of the nineteen cases, the parasites were associated with a non-suppurative catarrhal type of appendicitis. If the four cases of catarrhal oxyuris appendicitis of adults be also included, it may be said that 83 per cent. of the

Digitized by Google

cases of appendicitis associated with parasites have been of the catarrhal type. In the four remaining cases, the appendix was gangrenous. The cellular changes noted in the catarrhal cases have been distension of the crypts with mucus, hyperplasia of the lymph follicles, and in some cases, the presence of a few leukocytes in the muscularis and serosa.

4. In thirteen of the nineteen cases (70 per cent.), there have been noted, in addition to the cellular changes, certain lesions in the mucosa, unquestionably produced by the parasite. Of the six cases in which no specific lesions were demonstrated, the extensive gangrene in three of them might have obliterated specific lesions had they been present. Specific lesions were not demonstrated in any one of the four adult cases.

5. The oxyuris injures the mucosa by breaking through the lining epithelium and burrowing into the lymph follicles for a greater or less distance. Its invasion is usually accompanied by extravasation of blood into the surrounding lymphoid tissue, and its escape through the ruptured mucosa. In some cases, the oxyuris produces hemorrhagic ulcers in the mucous membrane, the edges of which are undermined and the bases formed by the submucosa. A characteristic feature of the oxyuris lesions is the absence of inflammatory reaction about them, except in those cases where there is secondary bacterial infection.

6. In some instances, the oxyuris may become encapsulated in the mucosa with fibrous tissue, and itself undergo hyaline degeneration. Such a process constitutes a healed oxyuris lesion.

7. The trichocephalus attacks the mucous membrane of the appendix in a manner similar to that described for the oxyuris and there is the same absence of inflammation about the invading parasite. The trichocephalus, however, instead of

Digitized by Google

invading a lymph follicle, shows a tendency to burrow along just beneath the columnar epithelium.

8. The conclusion to be drawn from these facts is that oxyuris and trichocephalus, when they occur in a diseased appendix are in most cases the exciting cause of the pathological changes found.

We are indebted to Dr. Blake and Dr. Eliot for permission to use the material from their services at the Presbyterian Hospital; to Dr. Charles Norris, of Bellevue Hospital; Dr. Humphreys, of the German Hospital; Dr. Elser, of the New York Hospital; Dr. Charles N. Dowd, of Roosevelt Hospital, and Dr. John C. Vaughan, for specimens; to Mr. Louis Schmidt, of the Rockefeller Institute for Medical Research, for the photographs.

CASE HISTORIES.

CASE I. J. P., female, 9 years. Operation, December 10, 1909.

The appendix is 7.5 cm. in length. The serosa is smooth, pale, and glistening. Except for a slight swelling, the appendix appears normal externally. The lumen contains bloody mucus in which are a number of thread-worms, 14 males, 3 females. Some of the worms are adherent to the mucosa. Mucosa swollen and marked by minute hemorrhagic foci.

Microscopical sections were cut in serials from various parts of the appendix; in all, 808 sections were made.

Microscopical Examination.—The lumen is filled with mucus in which are suspended many red blood corpuscles, considerable brown pigment, leukocytes, chiefly of the lymphoid type, and granular detritus. A few ova of trichocephalus also occur. The mucous membrane is intact in some sections. In others, it has been partially destroyed. These ulcers are lined with necrotic tissue which contains many red blood cells and a few lymphoid cells. The ulcers show a marked tendency to undermine the mucous membrane, some of them being continuous with necrotic tracts in the submucosa, which extend half way around the appendix. Lying in the ulcers and in their submucous branches are male thread-worms cut at various angles. Following these through the serials, one finds that they have gone in head first, and that they are boring their way beneath the mucosa (Fig. 5). The tunnels often terminate in lymph follicles, the keim centers of which are swollen and the seats of small hemorrhages. There is remarkably little inflammatory reaction about the ulcers and their branches. None of the ulcers reach the muscularis,

Digitized by Google

a thin strip of hyaline submucosa invariably separating them. The muscularis, however, is infiltrated with a moderate number of eosinophils. The serosa is somewhat thickened and infiltrated at some points by eosinophils, polynuclear leukocytes, and lymphoid cells.

Diagnosis—Hemorrhagic ulceration of the appendix by *Oxyuris vermicularis;* ova of trichocephalus dispar in the lumen; acute catarrhal appendicitis.

Case II. M. M., female, 12 years. Operation, December 11, 1909.

The appendix is 6 cm. in length. The serosa is smooth and glistening, but the vessels are injected. The mucosa is pale and swollen, and dotted with small purpuric areas. The appendix contains 28 oxyurides, 19 males, and 9 females. At one point near the tip, the tail of an oxyuris protrudes from the mucous membrane to a distance of 2 mm., the remainder of the worm being apparently buried beneath it.

Serial sections from various parts of the appendix, mostly through the hemorrhagic foci. Seven hundred sections were examined.

Microscopical Examination.—The hemorrhagic areas correspond to points where the oxyuris has invaded the wall of the appendix. A variety of lesions are seen, exemplifying the different stages of the parasite's invasion. In one, a male oxyuris is found curled up in a lymph follicle which as yet has suffered little or no damage from the presence of the worm [Fig. 4]. In tracing this lesion through the serial, a diagonal tract of necrosis, just wide enough to admit the worm can be found from the break in the mucosa clear down to the infested follicle. Another lesion shows a male oxyuris, again in a lymph follicle, but this time surrounded by a zone of necrotic tissue, outside of which occur large numbers of polynuclear leukocytes and eosinophils, and a few cocci and bacilli. A streak of necrosis connects this focus with the lumen of the appendix. At still another point, in the submucosa and surrounded by lymphoid tissue, there is seen a small focus of hyaline material surrounded by epithelioid cells, which are, in turn, enclosed by a dense fibrous capsule. In the midst of the hyaline area, the remains of an oxyuris can be clearly made out. The outlines of the parasite are sharp, but the structure of the worm has been in great part obliterated (Fig. 7).

The mucosa is intact except at those points where it has been destroyed by the invading pin-worms. The lymph follicles are swollen. The stroma about the crypts and follicles is infiltrated with large numbers of eosinophils and a few polynuclear leukocytes. The submucosa and muscularis contain many eosinophils. The serosa is thickened and infiltrated with eosinophils, lymphoid cells and polynuclear leukocytes.

Diagnosis.—Invasion of the mucosa of the appendix by *Oxyuris vermicularis;* encapsulated oxyuris in submucosa; acute catarrhal appendicitis.

Case III. T. D., female, 14 years. Operation, December 18, 1909.

The appendix is 6 cm. in length. The vessels of the mucosa are injected, and the serosa is smooth. The appendix is swollen. The lumen is large and

Digitized by Google

contains bloody mucus in which are seen many pin-worms, 35 in all, and only 5 males. A small part of the appendix near the tip is not opened. The mucosa is swollen and dotted with minute petechiæ.

Microscopical sections were cut in serials from various parts of the appendix. In all, 1948 sections were examined.

Microscopical Examination.—The mucosa for the most part is intact. Sections, however, through the petechiæ show extensive extravasations of blood into the lymph follicles. Hemorrhagic tracts lead from these into the lumen of the appendix, the blood passing out through small breaks in the superficial epithelium. In one of these hemorrhagic tracts, a female oxyuris is seen. Another parasite is seen in the act of invading the mucosa [Fig. 3]. The lymph follicles are considerably larger and more numerous than normally. There is some infiltration of polynuclear leukocytes and lymphoid cells about the blood vessels of the muscularis. The serosa is slightly thickened, and its vessels are engorged with blood. There is moderate infiltration of the serosa in places with polynuclear leukocytes and lymphoid cells.

Diagnosis.—Acute catarrhal appendicitis; invasion of the mucosa of the appendix by *Oxyuris vermicularis.*

Case IV. M. B., male, 8 years. Operation, February 18, 1910.

The appendix is 5 cm. long. It is swollen and rigid. The serosa is injected. The lumen contains blood and mucus, and one female oxyuris. The mucous membrane is reddened and swollen. Near the tip, there is a dark hemorrhagic area over which the mucosa is apparently ulcerated.

A long serial was cut through the hemorrhagic area, and shorter ones through other parts of the appendix. Altogether, 846 sections were examined.

Microscopical Examination.—Sections through the hemorrhagic focus show, at one point, an extensive extravasation of blood, with destruction of the overlying epithelium. On either side, the hemorrhage excavates the mucous membrane for some distance, separating the lymphoid structures from the submucosa. Mixed with the blood there is considerable granular detritus, and occasional small bits of material resembling the outer cuticle of an oxyuris. There is no inflammatory reaction about the hemorrhage. The lymph follicles in all parts of the appendix are swollen. The submucosa, muscularis, and serosa show no changes.

Diagnosis.—Hemorrhages from the mucosa of the appendix due to *Oxyuris vermicularis;* acute catarrhal appendicitis.

Case V. W. A., male, 14 years. Operation, February 25, 1910.

The appendix is 7 cm. in length. It is slightly swollen. The serosa is injected. The lumen contains yellow fecal material in which is found one female oxyuris. The mucosa is swollen, and in several places there are small, dark red, eroded foci that resemble ulcers.

Serials were cut from various parts of the appendix, at sites of hemorrhagic foci. In all, 366 sections were studied.

Digitized by Google

Microscopical Examination.—The only changes found in the appendix are those that occur in the mucosa. The lymph follicles are swollen, and at many points there are extensive extravasations of blood into the follicles, some of which are in direct connection with the lumen of the appendix by means of slender sinuses. Small areas of necrosis occur in some of these hemorrhages. One ulcer is found extending down into the submucosa. There is no infiltration of leukocytes, but the tissue about it is rich in young blood vessels and has the appearance of granulation tissue.

Anatomical Diagnosis.—Hemorrhagic ulceration of the appendix due to oxyuris; healing oxyuris ulcer; acute catarrhal appendicitis.

Case VI. J. D., female, 43 years. Operation, April 6, 1910.

The appendix is 6 cm. in length. It is slender, smooth, and pale. The lumen contains 6 pin-worms, 3 male and 3 female. The mucosa is pale. No hemorrhages. No ulceration.

Serials were cut through several different points. Five hundred and forty sections, in all. No oxyuris ulcerations are found. The mucosa contains many eosinophils, is absent in places, but the possibility of mechanical erosion cannot be excluded. The lymph follicles are swollen. The muscularis and serosa show, in places, groups of lymphoid and plasma cells. The lumen is larger than normal.

Anatomical Diagnosis.—Oxyuris in the appendix; acute catarrhal appendicitis.

Case VII. M. H., female, 10 years. Operation, April 21, 1910.

The appendix is 5 cm. long. It is somewhat swollen. The serosa is smooth and injected. Right at the tip, three oxyurides are found, 2 males and 1 female. One of the males is attached to the mucosa, but while under observation, is seen to free himself. The mucosa at the tip is reddened.

A complete serial section of the tip was cut, and shorter serials from various other parts of the appendix. Altogether, 422 sections were studied.

Microscopical Examination.—The mucosa is intact, except at the point where the male oxyuris was found attached to the mucosa. In this portion of the serial, cross sections of the parasite are seen lying free in the mucosa. At one point there is a fresh break in the epithelium, through which there is pouring out blood, rich in leukocytes. [Figs. 1 and 2.] This stream can be traced to the adjacent lymph follicle, in which there has occurred an extravasation of blood. There are small hemorrhages in some of the other follicles. All the follicles are swollen. Submucosa, muscularis, and serosa show no changes.

Diagnosis.—Puncture of the mucosa of the appendix by *Oxyuris vermicularis;* acute catarrhal appendicitis.

Case VIII. L., female, 6 years. Operation, May 20, 1910.

The appendix is 5 cm. in length, pale, but moderately swollen. The serosa is glistening. The lumen contains a small quantity of mucus in which there is

Digitized by Google

found one male oxyuris, and a dozen or more ova of oxyuris. The mucosa is swollen, but smooth and pale. No hemorrhagic foci are found.

Serial sections were cut at different points, 456 sections being studied.

Microscopical Examination.—The mucosa is intact except at a few points where artificial breaks are seen. The crypts are filled with mucus. The lymph follicles are considerably swollen. The muscularis and serosa are normal.

Diagnosis.—Oxyuris in the appendix; acute catarrhal appendicitis.

CASE IX. M. L., female, 8 years. Operation, June 4, 1910.

The appendix is 5.5 cm. in length. It is somewhat swollen, but the serosa is smooth and pale. The vessels of the serosa are injected. The lumen is found filled with bloody mucus in which there are found pin-worms, 2 males and 2 females, all located in the proximal half of the appendix. The lumen is large in this region, and the mucosa of the proximal half shows several small hemorrhagic ulcerations.

A serial of 96 sections was cut through one of the hemorrhagic areas.

Microscopical Examination.—The mucosa is covered everywhere with mucus containing many red blood cells. At one point the mucosa is absent and is partially replaced by necrotic tissue, mucus, and red blood cells. The base of this ulcer is formed by the submucosa. There is no inflammation about the ulcer. The edges of the ulcer are considerably undermined, the necrosis extending along for some diistance under the mucosa. [Fig. 6.]

A male oxyuris is found in the bed of another and similar ulcer.

Diagnosis.—Hemorrhagic ulceration of the appendix due to *Oxyuris vermicularis;* acute catarrhal appendicitis.

CASE X. Female, 8 years.

The appendix is 6 cm. in length. The serosa is smooth and pale. Lying on the mucosa there are five pin-worms, 2 males and 3 females. Under two of the worms the mucosa shows hemorrhagic ulceration. One of the other parasites is firmly attached to the mucosa.

Three serials were cut, making a total of 608 sections examined.

Microscopical Examination.—Sections taken through the attached parasite, show an adult female oxyuris invading the mucous membrane. The parasite has entered the mucosa through a small ulcer, and has burrowed out a deep sinus under the mucous membrane. There is a moderate amount of necrotic tissue about the worm, but no inflammatory change. At another point, a recent puncture wound is found, showing incipient destruction of the epithelium. The lymph follicles are large.

Diagnosis.—Ulceration of the appendix by *Oxyuris vermicularis;* acute catarrhal appendicitis.

CASE XI. K. K., female, 7 years. Operation, July 13, 1910.

The appendix is 4 cm. in length. It is swollen, reddened, and covered with fibrin. There are no perforations. On opening the appendix, 14 pin-worms, 2 males, and 12 females, are found in the lumen which is distended with foul smelling pus. There is a small fecal concretion in the central part of the

Digitized by Google

appendix. The mucosa of the distal three quarters is gangrenous and ulcerated. That of the proximal one quarter is smooth and pale.

Serials were cut through both the gangrenous and non-gangrenous portions, 342 sections being examined.

Microscopical Examination.—Sections through the gangrenous part show extensive destruction of the mucosa, the necrosis in places invading the submucosa and muscularis. At one point the entire wall is gangrenous. There is a dense and wide-spread infiltration of all the coats with polynuclear leukocytes. The serosa is thickened and infiltrated with leukocytes, and has a deposit of fibrin upon it.

Sections through the non-gangrenous portion show an intact mucosa, moderate swelling of the lymph follicles, a normal muscularis; and considerable fibrous thickening of the serosa. No evidence of invasion by oxyuris.

Diagnosis.—Oxyuris vermicularis in the appendix; acute gangrenous appendicitis.

CASE XII. J., male, 14 years. Operation, August 25, 1910.

The appendix is 7 cm. in length. The proximal third is smooth and pale. The distal two thirds is swollen, reddened, and covered with fibrin. One cm. from the tip there is a perforation which readily admits a probe. On opening the appendix, the mucosa of the proximal third appears a little congested and swollen, but otherwise normal. The mucosa of the distal two thirds is greenish gray and gangrenous. Just proximal to the perforation, the lumen of the appendix is markedly diminished by thickening of its wall. At the tip, the lumen is dilated, and contains a small concretion. One male oxyuris is found lying free near the tip.

Serials were cut from different parts; 188 sections in all.

Microscopical Examination.—The mucosa is for the most part gangrenous. At one place, the necrosis involves the entire wall. All the coats are infiltrated with leukocytes, the polynuclear type predominating in the mucosa, lymphoid cells and eosinophils in the muscularis. The serosa has been converted into a thick layer of granulation tissue. At several points there are pigmented foci in the gangrenous mucosa, but no definite oxyuris lesions are found in the sections examined.

Diagnosis.—Oxyuris vermicularis in the appendix; acute gangrenous appendicitis.

CASE XIII. E. M., female, 14 years.

The appendix is 6.5 cm. in length. It is swollen, reddened, and covered with fibrin. At the juncture of the middle with the distal third of the mucosa there is one male and one femal oxyuris, lying free. The mucosa is reddened and shows superficial ulceration. There is no perforation.

Two serials were cut, 140 sections in all.

Microscopical Examination.—The mucosa has been in large part destroyed.

The necrosis extends down into the submucosa at many places. The vessels are intensely congested. At one place the necrosis involves the muscularis.

Digitized by Google

The serosa is thickened, and densely infiltrated with polynuclear leukocytes. There is a deposit of fibrin on the serosa.

Diagnosis.—Oxyuris vermicularis in the appendix; acute gangrenous appendicitis.

CASE XIV. J. D., male, 10 years. Operation, December 15, 1910.

The appendix is 7.5 cm. in length, swollen but pale. The serosa is smooth and glistening. It contains feces, mucus, and 19 pin-worms, 7 males and 12 females. The mucosa is injected but shows no ulceration. The worms are lying free.

Several serials were cut, 640 sections being studied.

Microscopical Examination.—The mucosa is intact and covered with mucus. The lymph follicles are swollen. The submucosa, muscularis, and serosa show no changes. No evidence of oxyuris invasion.

Diagnosis.—Oxyuris vermicularis in the appendix; acute catarrhal appendicitis.

CASE XV. M. L., female, 54 years. Operation, January 10, 1911.

The appendix is 8 cm. in length, and moderately swollen. The serosa is smooth, pale, and glistening. It contains 6 pin-worms, 3 males and 3 females. The mucosa is swollen and injected in places, but shows no ulceration.

A serial of 456 sections was cut.

Microscopical Examination.—The mucosa is intact. The lymph follicles are swollen and many eosinophils occur in the mucosa. Submucosa, muscularis, and serosa are normal.

Diagnosis.—Oxyuris vermicularis in the appendix; acute catarrhal appendicitis.

CASE XVI. J., male, 37 years. Operation, January 13, 1911.

The appendix is 9 cm. in length, slightly swollen, but smooth, pale, and glistening. The lumen of the appendix contains mucus and 5 pin-worms, 3 males and 2 females. The mucosa is swollen and shows small red areas, but there is no visible ulceration.

Serials were cut from five different pieces, 540 sections being examined.

Microscopical Examination.—The mucosa is intact, but is covered in places by a layer of mucus, granular debris, and lymphoid cells. The follicles are swollen. The submucosa, muscularis, and serosa show no change. No oxyuris lesions are found.

Diagnosis.—Oxyuris vermicularis in the appendix; acute catarrhal appendicitis.

CASE XVII.—M. D., female, 15 years. Operation, February 20, 1911.

The appendix measures 8 cm. in length, and is moderately swollen. The serosa is smooth, pale, and glistening. The lumen is filled with bloody mucus. The mucosa is swollen and marked by two small hemorrhagic foci. Right at the tip of the appendix, one female oxyuris is seen, lying free on the mucosa.

Serials were cut on the tip, and also through the hemorrhagic foci—808 sections were examined.

Digitized by Google

Microscopical Examination.—Sections through the hemorrhagic foci show that the mucosa has been in part destroyed and its place taken by necrotic tissue in which red blood corpuscles and lymphoid cells occur. The necrosis extends down to the submucosa, and undermines the mucosa which still survives. There are no signs of cellular infiltration or repair about these lesions. The lymph follicles are swollen. The submucosa, muscularis, and serosa show no changes.

Diagnosis.—Hemorrhagic ulceration of the appendix produced by *Oxyuris vermicularis;* acute catarrhal appendicitis.

CASE XVIII. R. W., female, 23 years. Operation, February 20, 1911.

The appendix is 4 cm. in length, and is moderately swollen. The serosa covered with fibrous tags. The wall of the appendix is somewhat thickened. The lumen is empty, except near the tip where there is some mucus that contains 3 pin-worms, 2 males and 1 female. The mucosa is slightly injected, but smooth and glistening.

Several serials were cut, 322 sections being examined.

Microscopical Examination.—In two of the serials, the lumen of the appendix has been completely obliterated by a new growth of fibrous tissue. In others, the lumen survives and the mucosa is intact, but there is a deposit of mucus and lymphoid cells on it. The lymph follicles are swollen. The submucosa is thickened and hyaline. The muscularis is normal. The serosa is thickened and infiltrated in places with lymphoid cells.

Diagnosis.—Oxyuris vermicularis in the appendix; chronic obliterating appendicitis; acute catarrhal appendicitis.

CASE XIX. M. J., male, 5 years. Operation, February 25, 1911.

The appendix is 5 cm. in length, considerably swollen, but pale and glistening. The lumen contains a small quantity of mucus and 7 male pin-worms. The mucosa is swollen and shows several elevated hemorrhagic areas. The wall of the appendix is thickened.

Serials were cut at several points, 408 sections being studied.

Microscopical Examination.—Sections through one of the hemorrhagic areas show that at one point there is extensive extravasation of blood into a lymph follicle. The epithelium is absent over this point and the hemorrhage extends as far as the surface. The other follicles are greatly swollen.

On another section, a male oxyuris is found coiled up in a lymph follicle. There is no inflammatory reaction whatever about the parasite. Still another section shows a male oxyuris penetrating the mucosa through a narrow break in the epithelium. The submucosa and muscularis are normal. The serosa moderately thickened.

Diagnosis.—Invasion of the mucosa of the appendix by *Oxyuris vermicularis;* acute catarrhal appendicitis.

CASE XX. C. S., female, 15 years. Operation, March 3, 1911.

The appendix is 7.5 cm. in length. reddened, but smooth and glistening. The lumen contains soft yellow feces, in which are found 2 pin-worms, 1 male

Digitized by Google

and 1 female. There is a small hemorrhagic ulcer in the mucosa, just beneath the female. Elsewhere the mucosa is smooth, but swollen and marked by several small hemorrhages.

Several serials were cut, 710 sections in all being examined.

Microscopical Examination.—The mucosa is intact. The lymph follicles are swollen. The submucosa, muscularis, and serosa show no noteworthy changes. The serosa is somewhat thicker than normally. No oxyurides are found.

Diagnosis.—*Oxyuris vermicularis* in the appendix; acute catarrhal appendicitis.

CASE XXI. H., male, 18 years. Operation, October 7, 1911.

The appendix is 7.5 cm. in length, swollen, and injected, but the serosa glistens. A female oxyuris is found in the lumen, about 1.5 cm. from the tip, with its head buried in the mucosa. At about the mid-point of the appendix there is a small hemorrhagic ulcer. Elsewhere the mucosa is smooth, swollen, and covered with mucus.

Two serials were cut, 693 sections being examined.

Microscopical Examination.—Sections through the foci above referred to show rather extensive extravasation of blood into the swollen lymph follicles, the blood at one point pouring out into the lumen through a break in the epithelium. The submucosa, muscularis, and serosa are normal.

Diagnosis.—Puncture of the mucous membrane of the appendix (with hemorrhage) by *Oxyuris vermicularis;* acute catarrhal appendicitis.

CASE XXII. T. L., male, 7 years. Operation, May 26, 1910.

The appendix is 5 cm. in length, swollen, rigid, intensely reddened, and covered with a fibrino-purulent exudate. Near the tip there is a small perforation surrounded by a zone of necrotic tissue. On opening the appendix, a small fecal concretion is found at about the mid-point of the organ. Proximal to the concretion, the mucosa is smooth and pale. Distal to the concretion and surrounding it, the mucosa is gangrenous. Immediately proximal to the concretion one trichocephalus dispar is found firmly attached to the preserved portion of the mucosa.

A serial was cut through the point where the parasite was attached, another one through the gangrenous portion. Three hundred and eighty-eight sections were examined.

Microscopical Examination.—Sections through the non-gangrenous part show the mucosa intact, except at one point where the superficial columnar epithelium is reflected over the cross section of a tricocephalus. There is no inflammatory change and no hemorrhage. All the lymph follicles are swollen, however. The muscularis contains many eosinophils. The serosa is congested and infiltrated with lymphoid cells. There is a deposit of fibrin on the surface.

Sections through the gangrenous part show complete destruction of the mucosa. In some places the necrosis involved the entire wall of the appendix.

Digitized by Google

All coats are densely infiltrated with polynuclear leukocytes. The serosa has been converted into a thick layer of granulation tissue, on the surface of which there is a deposit of fibrin.

Diagnosis.—Invasion of the appendix by *Trichocephalus trichiura;* acute gangrenous appendicitis.

CASE XXIII. R., 12 years. Operation, December, 1910.

The appendix is 5 cm. in length. It is swollen and congested. The serosa is somewhat thicker than normally, but otherwise shows no significant changes. On opening the appendix, the mucosa is swollen but smooth. Near the base there is a trichocephalus dispar firmly attached by its head to the mucosa. There is little or no reaction about the point of its attachment.

A serial was cut through the point where the worm was attached. Two hundred and sixteen sections were examined. A few sections were also taken through the tip.

Microscopical Examination.—Sections through the point of attachment of the parasite, show sections of the parasite just beneath the columnar epithelium. One section shows the epithelium reflected over the parasite, which has apparently effected a break in the epithelium, and has then burrowed along just beneath it. [Fig. 8.] There is no inflammatory reaction about the lesion. The lymph follicles are moderately swollen. The submucosa is normal. The muscularis contains a moderate number of eosinophils. The serosa infiltrated with lymphoid cells and eosinophils.

Diagnosis.—Invasion of the mucosa of the appendix by *Trichocephalus trichiura;* acute catarrhal appendicitis.

AUTOPSY CASE I. B. H., male, 3 years. Cause of death meningitis.

The appendix measures 5 cm. in length, and is slender and pale. The serosa is smooth and glistening. The lumen contains a small quantity of soft feces, in which are found 3 male oxyurides. The mucosa is smooth, pale, and free from swelling.

A serial of 96 sections was cut at about the middle point.

Microscopical Examination.—The mucosa is intact. The lymph follicles are swollen. The submucosa, muscularis, and serosa are normal.

Diagnosis.—*Oxyuris vermicularis* in the appendix; hyperplasia of lymph follicles.

AUTOPSY CASE II. Male, 10 years. Cause of death diphtheria.

The appendix is 8 cm. in length, slender, smooth, and pale. The serosa glistens. The lumen contains soft yellow feces, in which are seen 2 pin-worms, a male and a female. The mucosa appears normal.

A serial of 88 sections was cut at the point where the parasites were located.

Microscopical Examination.—The mucosa shows some autolysis, but there are no pathological changes. The submucosa, muscularis, and serosa are normal. The lymph follicles are large.

Digitized by Google

Diagnosis.—Oxyuris vermicularis in the appendix; hyperplasia of the lymph follicles.

AUTOPSY CASE III. A., female, 3 years. Cause of death, measles.

The appendix measures 4 cm. in length. It is slender and pale, and apparently normal. The lumen contains 2 oxyurides. The mucosa shows no changes.

A serial of 108 sections was cut through a portion of the appendix lying just beneath one of the parasites.

Microscopical Examination.—The mucosa is everywhere intact. Many goblet cells are seen. The lymph follicles are large. The submucosa, muscularis, and serosa are normal.

Diagnosis.—Oxyuris vermicularis in the appendix; hyperplasia of the lymph follicles.

BIBLIOGRAPHY.

[1] Metchnikoff: Jour. de prac., 1901, XV, 185; Bull. de l'Acad. de méd., 1901, XLV, 301.

[2] Brumpt: Précis de Parasitologie, Paris, 1910, 355.

[3] Railliet: Compt. rend. Soc. de biol., 1911, LXX, 310.

[4] Hoepfl: Arch. f. klin. Chir., 1904, LXXIII, 100.

[5] Still: Brit. Med. Jour., 1899, I, 898.

[6] Brumpt and Lecene: Bull et mém. Soc. de méd. d. hôp. de Paris, 1909, XXVI, 215.

[7] Delsmitt: München. med. Wchschr., 1901, XLVIII, 1813.

[8] Oelnitz: Cong. de gynéc., d'obst., et d. pédiat., Nantes, 1901. Session of September 27th.

[9] Erdman: N. Y. Med. Jour., 1904, I, 537.

[10] Wakefield: Jour. Am. Med. Assn., 1908, L, 1904.

[11] Wagener: Virchows, Arch. f. Path. Anat., 1906, CLXXXII, 145.

[12] Walther: Bull. et mém. Soc. d. chir. d. Paris, 1905, XXXI, 355.

[13] Culhane: Jour. Am. Med. Assn., 1910, LIV, 48.

[14] Martin: Montpel. méd., 1907, XXIV, 531.

[15] Von Moty: Echo méd. du nord, 1902, VI, 217.

[16] Pabeuf and Dubois: Bull. méd., 1908, XXII, 153.

[17] Ashurst: Am. Jour. Med. Sc., 1909, CXXXVIII, 583.

[18] Begouin: Gaz. hebd. de sc. méd. de Bordeaux, 1902, XXIII, 363.

[19] Winkler: Die Erkrankungen des Blindarmanhanges, 1910, 234.

[20] Hippius and Lewinson: Deutsch. med. Wchschr., 1907, XXXIII, 1780.

[21] Weinberg: Ann. de l'Inst. Pasteur, 1907, XXI.

[22] Romanovitch: Compt. rend. Soc. d. biol., 1911, LXX, 122.

[23] Galli-Valerio: Centralbl. f. Bakteriol., Orig., 1903, XXXIV, 350.

[24] Unterberger: Centralbl. f. Bakteriol., Orig., 1908, XLII, 395.

[25] Wichman: Inaugural Dissertation, Kiel, 1889.

[26] Girard: Ann. de l'Inst. Pasteur, 1901, XV, 440.

[27] Schloss: Am. Jour. Med. Sc., 1910, CXXXIX, 675.

Digitized by Google

EXPLANATION OF PLATES.

FIG. 1. Case 7. Superficial puncture of the mucosa of the appendix by a male oxyuris. A small blood clot is seen protruding through a break in the mucosa. Cross sections of the oxyuris in the lumen. × 107.

FIG. 2. Case 7. The same lesion, highly magnified. The structure of the clot is well shown. × 320.

FIG. 3. Case 3. A male oxyuris, invading the mucosa. Early stage. × 107.

FIG. 4. Case 2. Invasion of a lymph follicle by a male oxyuris. Note the entire absence of inflammatory changes about the parasite. × 107.

FIG. 5. Case 1. Characteristic undermining of the mucosa by a male oxyuris. Necrosis but no inflammation. × 107.

FIG. 6. Case 9. A typical oxyuris ulcer, filled with blood and necrotic tissue. The necrosis undermines the sound mucosa for a short distance. × 107.

FIG. 7. Case 2. Hyaline oxyuris completely encapsulated by fibrous tissue. A healed oxyuris lesion. × 107.

FIG. 8. Case 23. Trichocephalus invading the mucosa. The parasite is burrowing along beneath the columnar epithelium which is shown reflected over it. No inflammatory changes. × 107.

Digitized by Google

Digitized by Google

XXIII.

OPERATIONS UPON THE APPENDIX.

ANALYSIS OF 1411 OPERATIONS PERFORMED AT THE PRESBYTERIAN HOSPITAL, NEW YORK.*

By CLARENCE A. MCWILLIAMS, M. D., ASSISTANT VISITING SURGEON.

This report is based upon all the operations performed upon the appendix by the various operators in the Presbyterian Hospital, New York, during the years 1906, 1907, 1908, and 1909. These numbered 1,411, divided in a general way as follows (see Table I): Acute cases 687, chronic and relapsing 512, and cases in which the appendix was removed in association with other procedures 212. This latter division will not be taken up at all in the first portion of this report which deals with operations on the appendix alone (*i. e.*, for appendicitis in some form) but will be considered as a separate heading in the last section.

SEX.

Analysis of the sex in the acute, chronic and relapsing cases shows a variation from that given by other writers. Thus Johnson ("Surgical Diagnosis," 1909), makes the statement that appendicitis occurs in the proportion of four men to one woman. The proportions in other statstics are:

* Read before the New York Surgical Society, February 9, 1910.

(*Reprinted from Annals of Surgery, June*, 1910.)

Digitized by Google

PERCENTAGE OF MALES.

	Cases	Per cent.
Sonnenburg	1000	67
Roux	670	53
Barbier	616	76
Deaver	300	61
Total	2586	64.2

In this series of 1,199 operations for acute, chronic and relapsing conditions, taken as a whole, there were 604 males, or 50.3 per cent., and 595 females, or 49.7 per cent., an almost equal number in each. There is no apparent reason why there should be a difference in the frequency in the two sexes. Our statistics show that the milder or more chronic the inflammation the more frequently does it affect the female. Thus in 512 chronic and interval operations, 37 per cent. only affected males, while 62 per cent. occurred in females. In the slightly severer inflammation (the acute catarrhal, 92 operations), the disproportion between the two sexes is less, though still more frequent in the female, 42 per cent. being in males and 57 per cent. in females. Very different proportions, however, are found when we analyze the 595 operations for the severe lesions, taken as a whole (suppurative, gangrenous and abscess conditions). In these 63 per cent. affected males and 37 per cent. females. One sex does not seem to be much more disposed in this last class of severe lesions to a fatal issue than the other. For if, as before, we exclude the acute catarrhal and include the suppurative, gangrenous and abscess cases (595 operations, total mortality 68, males 45, females 23), 66 per cent. of the deaths occurred in males and 33 per cent. in females, or a proportion of two males to one female dying, the frequency of occurrence in the two sexes (63 per cent. males, 37 per cent. females) being thus proportionately about equal to that of the mortality (66 per cent. males, 33 per cent.

Digitized by Google

TABLE I.—OPERATIONS UPON THE APPENDIX, PRESBYTERIAN HOSPITAL, NEW YORK.

	1909-1908				1907				1906				Totals, 1909-1906 inclusive			
	Total number	Recovered	Died	Mortality per cent.	Total number	Recovered	Died	Mortality per cent.	Total number	Recovered	Died	Mortality per cent.	Total number	Recovered	Died	Mortality per cent.
Acute catarrhal	42	42	0	....	18	18	0	....	32	32	0	....	92	92	0	0
Acute suppurative	85	84	1	....	36	36	0	....	33	30	3	....	154	150	4	2.5
Acute suppurative with abscess	13	13	0	....	2	2	0	....	18	17	1	....	33	32	1	3.3
Acute suppurative with diffuse or general peritonitis	8	4	4	50.0	2	1	1	50.0	3	3	0	0	13	8	5	38.4
Acute gangrenous	66	65	1	....	37	37	0	....	15	14	1	....	118	116	2	1.6
Acute gangrenous with abscess	78	75	3	....	37	36	1	....	32	27	5	....	147	138	9	6.1
Acute gangrenous with diffuse or general peritonitis	34	17	17	50.0	19	12	7	36.8	17	8	9	52.9	70	37	33	47.1
Incision of abscesses without removal of appendices	26	22	4	....	19	15	4	....	15	9	6	....	60	46	14	23.3
Acute cases, totals	352	322	30	8.5	170	157	13	7.6	165	140	25	15.1	687	619	68	9.8
Chronic and relapsing	262	259	3	....	126	126	0	0	124	124	0	0	512	509	3	0.5
Totals	614	581	33	5.3	296	283	13	4.4	289	265	25	7.9	1199	1128	71	5.9
Appendix removed in association with other procedures	127	127	0	....	38	37	1	....	47	47	0	0	212	211	1	0.4
												Totals	1411	1339	72	5.1

Digitized by Google

females), *i. e.*, sex does not seem to influence the mortality to any extent.

Age.

Kelly makes the statement that four-fifths of all cases of appendicitis occur before the age of thirty, and more than half before twenty. Our statistics do not quite bear these figures out (see Table II). Thirty-three and nine-tenths per cent. (404 cases), or a little over a third, occurred before twenty years of age, while 68.9 per cent. (821 cases), or a little over two-thirds, occurred before thirty. Nineteen per cent. (227 cases), occurred in patients between 30 and 40 years of age. The youngest patient was 21 months (recovered). The oldest was 72 years, in whom an abscess was opened without removal of the appendix. Cultures showed streptococci and colon bacilli. Death from sepsis.

TABLE II.—AGE OF PATIENTS.

Age	Acute cases				Chronic		Totals	
			Mortality					
	No. of cases	Percentage of total acute cases	Number	Per cent.	No. of cases	Percentage of total chronic	No. of cases	Percentage of whole
Under 5	16	2.8	3	18.7	.....	.....	.....	.....
Between 5 and 10	39	5.7	3	7.9	10	1.9	65	5.4
Between 10 and 20	217	31.8	24	11.0	122	24.0	339	28.5
Between 20 and 30	206	30.2	8	3.8	221	43.5	427	35.8
Between 30 and 40	118	17.3	12	10.1	109	21.4	227	19.0
Between 40 and 50	53	7.7	8	15.0	37	7.4	90	7.5
Between 50 and 60	24	3.5	4	16.6	7	1.3	31	2.5
Between 60 and 70	7	1.0	5	66.6	2	.4	9	.7
Over 70	2	.2	1				2	.1
Totals	682		68		508		1190	
Up to 20.....	272	39.8	.....	.....	132	25.9	404	33.9
Up to 30.....	468	68.6	.....	.....	353	69.4	821	68.9

The bearing which age has upon the mortality is interesting and instructive (see Table II). The extremes of life stand the disease badly. Under 5 years of age, there were 16 patients

Digitized by Google

operated upon with 3 deaths, or a mortality of 18.7 per cent. The high mortality in children under five, I believe to be due to the fact that the disease is more difficult to diagnose in them than in adults. It is also more treacherous and stealthy and the lesions severer with marked tendency to early perforation. The average day of the disease upon which these 16 children were operated was the fourth. The three deaths among them were in patients operated upon on the fourth day (2 cases) and fifth day (1 case), all 3 having gangrenous appendices associated with general peritonitis. The condition is usually diagnosed as acute gastritis, and only after the symptoms become serious is the correct one made. The shocking death rate of 66 2/3 per cent. is found in the 9 patients (6 deaths) who were operated upon for acute lesions over 60 years of age. I attribute this high death rate to the attempts on the part of the physicians who were first called to tide these patients over their acute attack, operation being hesitated in because of the increased risk due to their old age. This is a more unsafe view to take in these old persons than it is in younger persons, if such a thing be possible. The very increased risk, due to their diminished powers of resistance to infection, renders early operation imperative if we are to save them, earlier even than in younger persons. The durations of the disease in these 6 fatal cases were 10 hours, 30 hours, 4, 5, 10, and 11 days respectively.

The lowest death rate was found to be among the 206 patients between 20 and 30 years of age, of whom 8 died, or 3.8 per cent..

Analysis of the Mortality.

The total number of patients operated upon was 1,411, of whom 72 died, or a mortality of 5 per cent. (see Table I). Of these, 212, however, were cases in which the appendix was re-

Digitized by Google

moved in association with other procedures, which leaves 1,199 operations for some variety of appendicitis. These latter alone will now be considered.

In any given statistics the mortality rises and falls with the relative number of acute (and complicated) and quiescent (chronic and relapsing) cases operated upon, and to obtain a fair view of the actual operative mortality it is necessary to divide the operations into two distinct classes:

1. Those performed during quiescent periods of the disease, *i. e.*, for chronic and relapsing (interval) conditions.

2. Those performed in the presence of acute lesions.

1. Chronic and relapsing conditions: In this category there were 512 operations performed with 3 deaths, or a mortality of 0.5 per cent. These 3 deaths were as follows: One patient died on the twenty-first day after operation of lobar pneumonia and pulmonary thrombosis. The second patient died on the fourth day of acute nephritis (suppression). The third patient died on the fourth day of general septic peritonitis due to the shipping of the ligature off the stump of the appendix. In this case two plain catgut ligatures had been used without any subsequent burying of the stump. While a number of authorities advocate this method of treating the stump, the additional burying of the base of the appendix seems wiser and safer. Comment on these 3 deaths is unnecessary except to say that two of them were unavoidable, while the third should not have occurred. A number of cases are reported where the ligatures have slipped from the stump, *e. g.*, in the report of 2,000 appendix operations performed at Mt. Sinai Hospital, New York (Moschcowitz, Arch. f. klin. Chir., Bd. 82, Heft 3), this accident occurred in 2 cases.

Digitized by Google

2. Operations performed in the presence of acute conditions: Under this category there were 687 operations, with 68 deaths, or a mortality of 9.8 per cent. (see Table I).

Brewer, in his "Surgery" (1909), makes this statement as to the mortality in the acute cases: "In early acute cases when the inflammation is limited to the appendix, the mortality should not exceed 2 or 3 per cent., in abscess cases not greater than 5 per cent., but in late neglected cases where there is a diffuse peritonitis, the mortality will be from 50 to 80 per cent., the former figure representing the mortality to be expected in children, the latter in adults."

In the present statistics there was a mortality of 1.6 per cent. (364 patients, 6 deaths), in the early acute cases limited more or less to the appendix. In the abscess cases with removal of suppurative or gangrenous appendices, the mortality was 5.0 per cent. (180 patients, 10 deaths). In the abscess cases without removal of the appendices, the mortality was 23 per cent. (60 patients, 14 deaths). There was a mortality of 42 per cent. in the late cases with general peritonitis (83 patients, 35 deaths), *i. e.,* in children of 10 years or under, the mortality was 50 per cent. (14 cases, 7 deaths); in patients with general peritonitis over 10 and under 20 years of age, the mortality was 38.4 per cent. (26 patients, 10 deaths); in adults over 20 years of age with general peritonitis, the mortality was 48.4 per cent. (43 patients, 21 deaths).

For a satisfactory estimation of the results of operations during the acute stages, the classification adopted by Sprengel is the most convenient. Thus, *early operations,* those undertaken during the first 48 hours, *intermediate operations,* those performed from the third to the sixth day inclusive, and *late operations,* those performed from the sixth day onwards. The present status among surgeons of the question of operating in

Digitized by Google

acute appendicitis may be fairly stated briefly as follows: I quote freely from Murphy ("Keen's Surgery," Vol. IV, page 773): "From the clinical course and pathological changes, it is evident that the most favorable time for operation is within the first 32 hours of the attack, or, from a pathological basis, before perforation of the appendix or infection of the peri-appendicular tissues has taken place. The diagnosis can and should be made with accuracy in the great majority of cases before the end of the first 24 hours. From the symptoms and clinical course of the disease in the first 48 hours, it is impossible to predict with any degree of certainty what the subsequent course of the disease will be—that is, whether the tendency will be to subsidence and cure by the natural processes or to a virulent course, if not fatal termination. The danger of operation in this stage is but a trifle above that of the operation undertaken in the interval, while the patient is spared the dangers of serious complications." In short, patients with acute appendicitis should be operated upon immediately and this statement voices the views of most surgeons generally in America.

The intermediate stage, from the third to the sixth day inclusive: The question of whether to operate or not during this period is the crux of the whole appendix situation and unfortunately at the present time authorities differ as to the better plan of procedure. I quote again from Murphy: "Should we operate in the second (intermediate) stage, during the increasing or spreading inflammatory process which may mean anywhere from the second to the fifth day? In this stage we may have the circumscribed abscess around the appendix, an active inflammatory process of the neighboring tissues or organs, or the early pathologic changes of a circumscribed or general peritonitis. We often find the temperature and pulse

Digitized by Google

high, meteorismus, intestinal paralysis, and acutely infected tissues, with manifestations of severe intoxication at this stage. Shall we then operate?" The answer to this question divides the surgical world into two camps: the one advocates the Ochsner treatment of diminishing peristalsis and delaying operation in the hope that the diffuse or general peritonitis will subside into a local process and form a circumscribed abscess which can be opened later when the severe abdominal symptoms and general toxæmia have subsided. Some of their statistics are alluring (e. g., Guerry, Jour. Amer. Med. Assoc., Jan. 1, 1910); but, before being convincing, it will be necessary to know how many patients, treated in this way, die without localizing the process into an abscess, hence go unoperated. I have seen no such statistics. Patients who have strength enough to survive the battle are operated upon and the unfit are eliminated. This method seems ideal for the statistics of the operator and perhaps better calculated to minister to the surgeon's reputation than to the safety of the patient. How is any one to tell in advance whether a given spreading of diffuse peritonitis will not go on to a general and fatal peritonitis? Unquestionably it will not do so in the majority of cases, but it is the minority that we must seek to save.

The Ochsner method of treatment has been widely misunderstood and wrongly applied. Many have falsely interpreted it to mean that operation in all acute cases, even in the early stage, should be delayed, and great harm has been done because of the letting slip by of the most favorable time for successful operation, namely, at the outset. Perhaps it would be well to outline the Ochsner method of treatment, in order that there may be no misunderstanding as to exactly what is meant. We may divide it into two parts,—the first finds few dissenters among surgeons and relates to efforts which should be used to

Digitized by Google

diminish peristalsis, hoping thereby to limit the spread of the inflammation. It consists in the use of gastric lavage, the giving absolutely of no nourishment of any kind, no water, and no cathartics by mouth, the giving of no large enemata, the continuous administration of normal salt solution by rectum by the drop method, and the giving of nourishment exclusively by the rectum. The second and more criticized portion of the Ochsner treatment consists in the delaying operation in the severe (intermediate or late) cases in the hope that, by the employment of the means outlined above, peristalsis will be so diminished as to limit the spread of the diffuse or general peritoneal inflammation and that a local abscess will form which can later be opened. Further discussion of this topic will be found when considering mortality figures.

The second camp is made up of those who answer the question of whether to operate in the intermediate, or dangerous stage by a Yes. Morris (Jour. Amer. Med. Assoc., Jan. 1, 1910, Pagell) puts it as follows: "The Ochsner treatment is one of the most important things that was ever brought forward, but instead of carrying it out exactly as Dr. Ochsner does, I believe in doing an operation consuming 3 or 4 minutes. Get in, snap a forceps on the appendix and put in a little drain. You are not doing much to that patient. You are not lessening his chances very much." All the operators in the Presbyterian Hospital belong to this second camp and the statistics in this paper are made up of cases, with a few exceptions only, treated on such lines, viz., no delay in operating in all stages of the disease. A medical colleague (Fussell, New York Medical Jour., Jan. 22, 1910, p. 175) puts it well, as follows: "I thoroughly believe that at least three-fourths of the cases of appendicitis would recover if not operated upon but I know there are no symptoms that will tell when any case is approaching

Digitized by Google

the danger line until it is extremely dangerous either to interfere or to wait. I have said that the time to operate is when a diagnosis is made. I believe this holds good whether a diagnosis is made early or late. I am well aware that some of the best surgeons are opposed to this action. They teach that after a certain stage is reached it is safer to wait for resolution, or an abscess, and then operate. Truly if we were sure that the case would not perforate, or sure that the abscess would not rupture into the abdominal cavity, that is good advice. But no man can be sure of this. We *can* be sure of a very small mortality if a good surgeon operates at any time. It seems just as rational to operate if there is pus in the abdomen whether it be due to appendicitis or to a perforated ulcer."

Factors Influencing the Death Rate.

We have already noted the effect which the age and the sex have upon the prognosis. It is instructive to examine the acute cases to see how the presence or absence of previous attacks and the duration of the disease at the time of operation influence the proguosis.

Previous Attacks in the Acute Cases.—By reference to Table III, we find that of the 647 acute cases in which the presence or absence of previous attacks are given, 34 per cent., or a little over a third of the patients, had had one or more previous attacks, while 65 per cent., or a little less than two-thirds, had had no such previous attack. In a general way we may infer by analyzing this table that the milder the pathological lesion, the more likely is the patient to have had one

Digitized by Google

TABLE III.—PREVIOUS ATTACKS IN ACUTE CASES.

Acute catarrhal	None—40 or 44.4 per cent. Present—50 or 55.5 per cent.
Acute suppurative	None—89 or 60.5 per cent. Present—58 or 39.5 per cent.
Acute suppurative and gangrenous cases with abscesses	None—118 or 69.4 per cent. Present—52 or 30.5 per cent.
Incision of abscesses without removal of appendices	None—37 or 72.5 per cent. Present—14 or 22.5 per cent.
Accute suppurative and gangrenous appendices with general peritonitis	None—55 or 73.3 per cent. Present—20 or 26.6 per cent.
Total, 647 cases	None—422 or 65.2 per cent. Present—225 or 34.7 per cent.
Fatal cases, 58	None—50 or 86.2 per cent. Present—8 or 13.9 per cent.

or more previous attacks, and the severer the lesion the less likely. Thus in the acute catarrhal cases, 55 per cent. had had previous attacks, in the next severer type, the suppurative, 39 per cent. only had had previous attacks while in the acute suppurative and gangrenous cases with abscesses, 30 per cent. gave a history of previous attacks. Twenty-six per cent. of the patients with the severest lesions, those with general peritonitis, or a little over a quarter of the patients so affected, had had previous attacks. The most striking fact, however, is elicited from this table from the fatal cases. But 14 per cent. of the fatal cases, or about one-seventh, had had previous attacks. We may infer from this, I think, that antecedent attacks tend to surround the appendix with protective adhesions so that in a subsequent attack general peritonitis is less likely to occur. In addition it is more than likely that a local, protective hyperleucocytosis is formed by the antecedent infections.

Our statistics show that of the patients with acute inflammations who had had previous attacks, the recurrences took place in 38 per cent. (somewhat over a third) within six

Digitized by Google

months, 66 per cent., or two-thirds, within the first year, and 82 per cent., or somewhat over four-fifths, within two years of the first attack.

A trifle over half the patients (53 per cent.) who had had previous trouble (see Table IV) had had but one previous attack, 21 per cent., or somewhat over one-fifth, had had two attacks, while 25 per cent., or one-quarter, had had more than two previous attacks.

TABLE IV.—PREVIOUS ATTACKS.

Number	Number of Patients.	Percentage.
One attack	102	53.1
Two attacks	41	21.3
Three attacks	7	3.6
Four attacks	7	3.6
Five attacks	3	1.5
Six attacks	2	1.0
A "number" of attacks	27	14.0
Ten attacks	2	1.0
Twelve attacks	1	.5
Total	192	

Duration of the Disease at the Time of Operation and Its Effect upon the Mortality.—Whatever may be the difference of opinion as to the best treatment of the acute cases after the second day of the disease, surgeons are generally of the opinion that the greatest factor in reducing the mortality is the earliest possible removal of the appendix after the onset of the disease (see Table V). Thus, 20 of our cases were operated upon within 16 hours of the beginning of symptoms, only one of whom died (64 years old), on the ninth day after the removal (10 hours after the onset) of a suppurating appendix, from a complication (acute pericarditis in association with chronic valvular disease) which could not have been seen nor avoided. In this fatal case the abdominal conditions at the time of death were perfectly satisfactory. We may safely assert then

Digitized by Google

that operations for acute appendicitis performed within 16 hours of the onset will commonly result in no mortality, except that due to very exceptional circumstances. There were 115 patients operated upon between the sixteenth and twenty-fourth hours after the onset, with a mortality of 4, or 3.4 per cent. Three of these four patients had gangrenous appendices with diffuse peritonitis and died on the third, sixth and twenty-second days after operation respectively, as the direct result of peritonitis, *i. e.*, sepsis. Smears and cultures of the exudates showed the infections in one to be caused by streptococci with colon bacilli, in the second by streptococci alone and in the third by pyocyaneus with colon bacilli. The fourth patient had a gangrenous appendix and died on the ninth day of sudden pulmonary embolism, that apparently unavoidable complication which may be met with in almost any operation of whatever nature. Such cases illustrate only too strikingly how treacherous this disease may be even within a comparatively few hours of the onset and how necessary it is that, unless definite contraindications exist, operation should be undertaken at the very outset without waiting for the development of symptoms indicating whether the attack is going to be a mild or severe one. Murphy says ("Keen's Surgery"): "To me there appears to be no excuse, no explanation, no logical process for, no justifying hope in, delay in this disease." These fatal cases make one face the discouraging fact that, operate, however so early we may, there is likely to be a certain unavoidable mortality.

With the passage of time after the first day the mortality mounts. Thus on the second day, there were 145 patients operated upon with 9 deaths, or 6 per cent. of those operated upon during that time. Peritoneal sepsis was directly responsible for death in 6 of these cases, 2 others died after operations for

Digitized by Google

intestinal obstruction, while the ninth died of pneumonia. Of 103 patients operated upon on the third day, 8 died, or a mortality percentage of 7.7. The fourth day gives a death rate of 18 per cent. (72 operations, 13 deaths). The operations on the fifth and sixth days are about equally fatal, each 14 per cent. If we combine the operations performed from the third to the sixth days inclusive the mortality is 12.7 per cent. This is the so-called dangerous period in which Ochsner and his followers do not operate but wait, expecting to open a local abscess later. What are the results if we do operate later than the sixth day? Before answering this inquiry, let us see what the adherents of the Ochsner treatment believe to be the best days on which to operate.

TABLE V.—DURATION OF DISEASE AT TIME OF OPERATION.

	Number of cases	Died	Mortality per cent	Combined statistics	Number of cases	Died	Mortality per cent
1st day	135	5	3.7	On or before the second day	280	14	5.0
2d day	145	9	6.2				
3d day	103	8	7.7	From the 3d to the 6th day inclusive	251	32	12.7
4th day	72	13	18.0				
5th day	55	8	14.5				
6th day	21	3	14.2				
7th day	48	10	20.8	From the 7th to the 10th day inclusive	79	16	20.2
8th day	11	2	18.1				
9th day	5	1	20.0				
10th day	15	3	20.0				
11th day	4	1	25.0	From the 10th to the 14th day inclusive	52	8	15.3
12th day	5	1	20.0				
13th day	1	0	0				
14th day	27	3	11.1				
17th day	1	0	0	All acute cases operated upon after 6th day	156	21	13.4
21st day	5	0	0				
Data missing	34	1	0				
Totals	687	68	9.8				

In a remarkable series of appendix operations published by Guerry (Jour. Amer. Med. Assoc., Jan. 1, 1910, page 4) and treated by the Ochsner method, he says that the patients coming into his hands on the third and fourth days were tided through this period of great danger and "several days" later were safely

Digitized by Google

operated on for localized appendicits. Again Haggard (same journal, p. 10) suggests waiting until the tenth to the fourteenth day. Stanton (same journal, p. 10) says, "if things are let alone for a few days it will be found that all these patients at the eighth or ninth days have localized abscesses, an easily treatable — surgically drainable — lesion. These abscesses should not be allowed to go beyond this period, for it is after the twelfth day that we find the pus beginning to seek exits of its own—pyemia, metastatic abscesses, etc.

If we take Guerry and Stanton's time to operate as any day from the seventh to the tenth, by analyzing our statistics (see Table V) we find that we have not gotten as good results as though we operated from the third to the sixth day inclusive. For, from the seventh to the tenth day inclusive, the mortality was 20 per cent. of those operated upon during that period (79 operations, 16 deaths) as against a mortality of 12 per cent. of those operated upon from the third to the sixth day inclusive. If we take Haggard's time for operation as from the tenth to the fourteenth day inclusive, we find that the mortality is 15.3 per cent. (52 cases, 8 deaths), which is a somewhat better showing than operations performed from the seventh to the tenth day inclusive, but not so good as the results obtained when the operations were performed from the third to the sixth day.

I submit that there may be a different type of appendicitis in New York City from that found in South Carolina, Tennessee or Illinois. Our patients are drawn from the poor sections of the East Side of New York City and are ill calculated to withstand and overcome prolonged sepsis such as occurs with the Ochsner treatment. It may be that acute appendicitis requires different treatment in various sections of the country.

Digitized by Google

Let me instance 4 cases treated according to the Ochsner method, all with fatal results.

CASE 2087.—Male, 32, sick 14 days, localized abscess size of adult head. Incision, appendix not removed. Seven days after first operation, subdiaphragmatic abscess opened in tenth space, posterior axillary line, under cocaine anæsthesia, evacuating a pint and a half of pus. Death three days later from exhaustion.

CASE 2462.—Male, 51, sick five days, condition poor, very tender and rigid over whole right half of abdomen. Ochsner treatment until the tenth day, then operation. At least a quart of thick, fecaloid pus escaped. Cavity extended from liver to pelvis. Gangrenous appendix lay loose in cavity. Ligature to stump. Drainage. Time of operation 15 minutes. Died on the second day following of exhaustion.

CASE 4110.—Male, 48, sick 2 days. On admission great distention over whole abdomen, vomiting every few moments. Ochsner treatment until seventh day. Slight general and local improvement, but not sufficient to warrant further delay. Incision in right side, evacuating in a spurt large quantities of pus under great tension. No search for appendix. Drainage. Died on the second day from exhaustion.

CASE 895.—Female, 17, pregnant 6 months. Sick 3 days. Ochsner treatment until eighth day, then operation. Gangrenous appendix removed and a large abscess evacuated of which the large uterus formed one wall. Aborted 9 hours after operation. Death on the third day after operation of exhaustion.

In patients such as we see, a few experiences such as the above have discouraged us from wide application of the Ochsner method.

In 3 fatal cases with severe symptoms (all had gangrenous appendices with general peritonitis, and of 2, 5 and 7 days' duration respectively) the blood contained, as shown by cultures, on one case streptococci, in the second colon bacilli and in the third staphylococcus aureus. Few such cases will be saved by any form of treatment, but is it not much more rational to at once remove the primary focus and to divert it externally by a quick operation, so as to diminish as much as possible the absorption of organisms, than to adopt the expectant method of delayed operation trusting the patient to take care of such an amount of infection unaided? Under the

Digitized by Google

Ochsner treatment I believe none of these cases would have reached the time for operation, but if the Ochsner method had been adopted our statistics would have been improved by just so many fewer fatalities.

While on the subject of the mortality, it may be pertinent to say that the incision of abscesses alone without the removal of the appendices has not proved very satisfactory (see Table I). Deaver (ANNALS OF SURGERY, Dec., 1909) voices the same sentiment. Haggard in the article quoted above says this: "There are a great many delayed cases in my section of the country and we operate on these simply by incision and drainage. We do not bother about the appendix and *all the patients recover.*" We do not get such results in New York, for of 60 cases simply drained, 14 died, a mortality of 23 per cent. of cases so treated. I may say, however, that a number of these cases were operated on in the presence of general peritonitis in which the incision was a *dernier ressort.* The durations of the disease in these 14 fatal cases, treated by simple incision without removal of the appendices, were:

Days duration.	Cases.	Days duration.	Cases.
3	2	8	1
4	1	9	1
5	1	12	1
6	1	14	3
7	3		

The causes of death in these 14 cases treated by simple incisions alone were as follows:

Causes.	Cases.
Pulmonary embolism	2
Numerous pus pockets or secondary abscesses	4
Septic infarcts of lung and liver	1
Continued sepsis	7

In the Surgical Report of St. Luke's Hospital, New York, it is stated that in 1908 the appendix was not removed in 16 cases with 3 deaths, or 18 per cent. mortality.

Digitized by Google

I may state that blood pressures were taken in about 30 of the acute cases before operation, but that these blood pressures indicated nothing from a prognostic standpoint, the pressures not varying to any significant extent in the favorable and fatal cases until just before death.

THE CAUSES OF DEATH IN THE ACUTE CASES.

	Cases.
Intestinal obstruction	4
Continued sepsis	53
Pulmonary embolism	3
Pneumonia	2
Abscess of lung	1
Septic infarcts of lung and liver	1
Pericarditis	1
Diphtheria	1
Pylephlebitis	1
Hemorrhage from ulcer of intestine	1

A collective investigation by a commission of the Berlin Medical Society of the appendix operations which had been performed in the Berlin hospitals during the entire year of 1907, reported as follows:

In 1344 acute cases, 197 died: mortality per cent. 14.6; in 105 operations on first day, 1 died: mortality per cent. 0.9; in 318 operations on second day, 23 died: mortality per cent. 7.0. Total mortality first two days, 5.6 per cent.; in 238 operations on third day, 23 died: mortality per cent. 10.0; in 683 later operations, 150 died: mortality per cent. 23.0.

Different ages show different results:

Years.	Mortality per cent.
0-10	17.4
10-20	5.3
20-30	10.0
30-50	21.0
50-70	30.0

The following is the report of the appendix operations performed in the Heidelberg Clinic in 1908:

	No. of Cases.	Recovered.	Died.	Mortality per cent.
Operations within the first 3 days	29	26	3	13.4
Operations after the first 3 days	58	53	5	8.6
Interval operations	51	51	0	
Totals	138	130	8	5.8

Digitized by Google

In 1198 operations in Mt. Sinai Hospital, New York, for all varieties of appendicitis, performed during the four years from 1903 to 1906 inclusive (Moschcowitz, Archiv. für klin. Chir., Bd. 82, Heft 3), there were 68 deaths or a mortality of 5.6 per cent.

Complications Occurring in the Acute Cases Post-Operative (See Table VI).

Pregnancy was a coincident condition in 6 cases, one at 2 months, 1 at 3 months, and 2 at 4 months. None of these 4 patients aborted after operations for severe lesions nor did any of them die. Two were operated upon when pregnant 6 months. Both of these aborted spontaneously, one 9 hours, the other 2 days after operation and both these patients died. It is thus evident that pregnancy may be a serious complication if acute appendicitis occurs during the later months of pregnancy, and is a condition which urgently requires early operation to prevent the death of the child from sepsis and that of the mother from exhaustion. For a report of 276 cases of pregnancy associated with appendicitis see Renvall, Mitteilungen, etc., Bd. VII.

Pulmonary embolism occurred 4 times, or 0.5 per cent. in 687 acute cases, with 3 deaths. In none of these cases was there a coincident visible phlebitis. The deaths from this cause occurred on the third, ninth, and tenth days respectively. In the patient who recovered this complication occurred on the ninth day. The only known methods of avoiding embolism and thromboses are more or less theoretical. Foods capable of increasing the coagulability of the blood (this favoring thromboses) should be avoided, such as milk, fleshy foods and substances rich in gelatin and alkaline earths. The circulation should be stimulated by allowing freedom of movements in bed. In this last regard the Mayos, Murphy, Ries, Boldt, Gordon,

Digitized by Google

TABLE VI.—COMPLICATIONS IN ACUTE CASES.

	Recovered.	Died.	Total Cases.	Percentage of occurrence in 687 acute operations.	Mortality per cent.
Diphtheria	..	1	1	....	....
Quinsy	1	..	1	....	....
Parotitis, double	1	..	1	....	....
Pregnancy	4	2	6	....	....
Phlebitis	5	0	5	0.72	....
Pulmonary embolism	1	3	4	0.58	75.0
Secondary abscesses	14	4	18	2.6	22.2
Ileostomy for paralytic ileus	2	10	12	....	83.3
Mechanical intestinal obstruction	2	4	6	0.87	66.6
Fecal fistulæ	23	3	26	0.37	11.5
Pylephlebitis	..	1	1	....	....
Pneumonia	4	5	9	1.3	55.5
Pleurisy	2	2	4	....	....
Abscess of lung following pneumonia	..	1	1	....	....
Acute pericarditis	..	1	1	....	....
Septic infarcts, lung and liver	..	1	1	....	....
Delirium tremens	2	..	..	....	....
Hemorrhage from intestine	..	1	1	....	....

Currier, etc., advocate as a prophylactic agent, the early getting up of the patient upon the theory that the heart contractions are less vigorous in the recumbent posture: that the residual blood from insufficient ventricular action is peculiarly liable to coagulation. All of which is in part avoided by the upright posture and physical exertion. Most important to decrease the coagulation of the blood is the administration from the start of large quantities of water by mouth or rectum or under the skin.

Phlebitis occurred in but 5 cases, 0.7 per cent. of the whole 687 acute cases, with no fatalities. It developed on the tenth, twelfth, fourteenth (2 cases) and seventeenth days respectively and lasted from two to three weeks.

Digitized by Google

Secondary abscesses have required to be opened in 18 cases, or 2.6 per cent. of all the operations for acute conditions, with a mortality of 4. Five of these abscesses were on the left side, 4 in the pelvis, requiring vaginal section, and 3 were subdiaphragmatic on the right side. The fourteenth day after the

TABLE VII.—RESULTS OF CULTURES AND SMEARS.

Organisms.	Number of cases.	Percentage of frequency.	Mortality number of cases.	Mortality per cent.
Colon	165	57	17	10.3
Colon and pyocyaneus	4	..	2	50.0
Colon and staphylococci	5	..	..	....
Colon and pneumococci	6	..	1	16.6
Colon and streptococci	55	19	10	18.8
Colon and B. mucosus	4	..	1	25.0
Colon strep. and staphyl.	2	..	..	....
Colon strep. and pneumo.	1	..	..	....
Colon strep. and pyocyaneus	3	..	1	33.3
Colon strep. and B. aerog. c.	1	..	..	....
Streptococci	24	8.3	4	16.6
Strep. and B. mucosus	1	..	..	....
Strep. staph. and pneumo.	1	..	..	....
Strep. and pneumococci	1	..	..	....
Pneumococci	3	..	1	....
Pyocyaneus	2	..	1	....
Bac. mucosus	5	..	..	....
Staphylococcus albus	4	..	1	....
Paracolon	1	..	..	....
Total	288	..	39	....

original operation was the average time that these secondary operations were performed. To be noted is the frequent absence of pain and tenderness in abscesses deep down in the pelvis with the consequent liability to overlook them.

Intestinal obstruction seems to have been a particularly fatal complication in this series. For paralytic ileus, ileostomy was performed in 12 cases with a mortality of 83 per cent. of those so treated. Except in unusual circumstances, such as,

Digitized by Google

for example, where there is some doubt as to whether there may not exist a mechanical obstruction in association with the peritonitis, ileostomy scarcely seems worth while doing in paralytic ileus (peritonitis). Mechanical intestinal obstruction was met with in 6 cases, with the high death rate of 66 per cent. These patients were operated upon on the sixth, tenth, eleventh, fifteenth (2 cases) and nineteenth days respectively after the original appendix operations. The obstructions were caused in 2 cases by the pressure of abscesses, in 2 cases by bands and in 2 cases by kinks produced by adhesions.

Fecal fistulæ developed in 26 cases, or in 0.3 per cent. of the 687 acute operations. But 3 of these patients died, and these deaths could in no way be attributed to the fistulæ. The average day on which the fecal discharges from the wound appeared was the fourth and the average duration was nine days, except in one instance where a large patch from the cæcal wall sloughed. This was the only patient who required operation for the closure of the fistula which, in this instance, persisted for one year despite two operations for its closure. The less the handling of the gut at the time of operation, the less the liability to this uncomfortable complication. Extensive manipulations are more responsible for their development than is the pressure of rubber tubes.

There were 9 patients who developed pneumonia, or 1.3 per cent. of those operated upon for acute conditions. The mortality was high, 5 deaths, or 55 per cent. of those so affected. It is more than likely that pneumonia in acute appendicitis is septic in origin, either by emboli or through the lymphatics, hence it is a serious complication. An interesting but puzzling complication was met with in one of the fatal cases, namely, hemorrhage from the intestinal tract. The case is as follows:

Digitized by Google

Female, 42 years of age. Sick three days. Gangrenous appendix removed. Diffuse peritonitis. One cigarette drain. Two catgut ligatures to stump of appendix. No inversion. On the sixth day after operation, ileostomy performed, through the original wound, for distention and paralytic ileus. Progressive improvement until the sixteenth day when without any premonition or change in the condition of the patient, the abdominal conditions being apparently normal, there was a profuse hemorrhage which came from the interior of the intestine through the ileostomy opening. This hemorrhage was repeated in large amount and without apparent cause on the next day and again on the succeeding day, which latter was fatal. No autopsy.

Post-operative stomach and intestinal hemorrhages after appendicitis operations is discussed by Schwalbach (Deut. Zeit. fur Chir., Bd. 95, H. 1-5, p. 141), who collected 30 cases, of whom 17 died as a result. His conclusions are: The stomach and intestinal hemorrhages after appendix operations represent an infrequent complication. Its occurrence in children is especially frequent (one-third) and in men more often than in women. The pathological-anatomical findings consist in hemorrhages, erosions and ulcerations in the stomach and intestines. The origin of these is to be referred to thromboses in the venous and arterial circulatory systems of the omentum and mesentery. The prognosis is serious and the treatment symptomatic.

The remaining complications can be seen from Table VI and require no comment.

In order of frequency of occurrence and relative mortality, the important complications after acute appendix operations range themselves as follows:

FREQUENCY.

	Per cent. of acute cases.
1. Secondary abscesses	2
2. Pneumonia	1
3. Mechanical intestinal obstruction	0.8
4. Phlebitis	0.7
5. Pulmonary embolism	0.5
6. Fecal fistulæ	0.3

Digitized by Google

MORTALITY.

	Per cent. fatal.
1. Pulmonary embolism	75
2. Mechanical intestinal obstruction	66
3. Pneumonia	55
4. Secondary abscesses	22

Results of Cultures and Smears.

Few conclusions can be drawn from these in our series. Prior to 1908, tube cultures alone were taken of the peritoneal exudates, resulting in the majority of cases in a pure growth of B. coli. This is inaccurate because the B. coli readily overgrows and destroys less vigorous organisms. Since the latter part of 1907, smears in addition have been taken at the time of operation. Examination of these has shown a larger number with a greater variety of mixed infections than with the cultures alone (see Table VII). Probably the vast majority of appendiceal cases are due to mixed infections (Welch). In order that the various forms should be properly isolated, it would be necessary to make careful plate cultures at the time of operation and also cultures under anærobic conditions. Adami says that it is likely, also, that during life the same destruction of the weaker organisms by the B. coli takes place, so that the culture methods may reveal only a single germ when the disease has really been brought about by several.

In one fatal case in our series, smears and tube cultures of the peritoneal exudate showed streptococci and B. coli, whereas a blood culture in the same case revealed a pure growth of staphylococcus aureus. In a second fatal case, a pure growth of B. coli was obtained in blood culture and in a third fatal case a pure growth of streptococci. In each of these two latter cases, cultures from the peritoneal exudates gave a single organism corresponding to that in the blood.

Digitized by Google

A number of our earlier cultures were sterile, due to faulty technic in that the swab was dipped in the exudate without coming in contact with the intestinal serosa itself. A given exudate may itself contain few germs while its enclosing walls contain myriads of them, clinging to or engaged in the fibrinous exudate covering the serous surfaces. Hence the swab should always be brushed against the intestinal walls. The same statement applies to the knee joint, in which the free exudate may be found sterile (*e. g.,* by aspiration), whereas, could a culture be obtained from rubbing the synovial membrane itself, some organism would be obtained.

In Kelly's 400 cases, the B. coli was present in 92 per cent. In this series of 288 cases, it was found alone or in combination (see Table VII) in 82 per cent. (236 cases). The streptococcus (alone or in combination) was obtained in 30 per cent. (89 cases). All other organisms but these two seem to play but a subordinate role in our series so far as numbers are concerned, for the B. pyocyaneus was present in but 9 cases, the pneumococcus in but 12 and the streptococcus in 12.

With such a mixture of infections as our table indicates, it can be readily imagined how little good treatment by antisera vaccines would be likely to accomplish in peritonitis of appendiceal origin or, for that matter, in any perforative lesion of the intestinal canal.

Removal of the Appendix in Conjunction with Other Procedures.

It is not my purpose to discuss to any extent the question of whether the appendix should be removed when accessible in cases in which the abdomen is opened for the relief of some other pathological condition, or whether it should be left *in situ.* The main argument advanced against doing so is that it

Digitized by Google

will increase the mortality. This contention is not sustained in the 212 operations performed in the Presbyterian Hospital during the years 1906, 1907, 1908 and 1909, in which the appendices were removed in association with other primary procedures, the appendectomies being entirely secondary. I have seen no list of such operations to prove that the removal of the appendices will prejudice recovery, provided reasonable judgment be exercised in each individual case.

LIST OF PROCEDURES IN ADDITION TO APPENDECTOMY.

	CASES
Broad ligament cyst	3
Ovarian cysts	32
Uterine fibroids as follows:	
Hysterectomy	19
Myomectomy	13
Uterine myomectomy with radical cure inguinal hernia	1
Ruptured extrauterine pregnancy	2
Ventrosuspension in some form	15
Ventrosuspension with perineorrhaphy	2
Ventrosuspension with hemorrhoids	1
Perineorrhaphy	2
Perineorrhaphy trachelorrhaphy	1
Perineorrhaphy trachelorrhaphy and ventrosuspension	2
Bilateral trachelorrhaphy	1
Endometritis	4
Salpingitis	26
Pyosalpinx single and double	30
Pelvic peritonitis	5
Gonorrhœal peritonitis	1
Pneumococcus peritonitis	1
Pelvic hematocele	1
Chronic pancreatitis	1
Cholecystostomy for calculus	1
Cholecystectomy with choledochotomy	1
Freeing adhesions about pylorus	2
Exploratory gastrotomy for ulcer	1
Prolapsed liver and adherent omentum	1
Tuberculous cæcum	2
Splitting capsule of kidney	1
Persistent kidney sinus (appendix in sinus)	1
Nephropexy	18

Digitized by Google

Nephropexy with ventrosuspension	1
Ureteral calculus	1
Inguinal hernia (appendix as content)	3
Double inguinal hernia	1
Single inguinal hernia	5
Ventral hernia	2
Double femoral herniæ	1
Reduction of intussusception	2
Suppurative ulcerative colitis (only fatal case)	1
Bullet wound; suture of intestinal perforations	1
Hemorrhoids	3

The only fatal case in this list was one in which there was an intense suppurative, ulcerative colitis (autopsy) in which a cæcostomy was performed in addition to the removal of the appendix. The appendectomy had nothing to do with the fatal issue.

Digitized by Google

XXIV.

THE TREATMENT OF SPREADING PERITONITIS FOLLOWING APPENDICITIS.*

By John A. Hartwell, M. D., Assistant Visiting Surgeon.

The management of an extensive spreading peritonitis following appendicitis, presents questions which every surgeon frequently must answer, and as the condition is always a menace to life, the experience of each of us is important. During the summer, there have come under my care in the Presbyterian Hospital twelve such cases, and for the privilege of operating on them I wish to express my thanks to Drs. Eliot, Woolsey and Hawkes of the attending staff. All these cases have been treated in the same general way, and all have recovered, so that an analysis of the conditions found, and the results, may be of value in deciding some unsettled points concerning them. Eight were males, and four were females. The youngest was eight years old; five being in children under thirteen, and the oldest was forty. Nine were suffering from their first attack; two from their second, and one from his third. Five were operated about twenty-four hours after the onset of acute symptoms; one on the second day, two on the fourth day; one on the seventh, and one on the ninth. All, without exception, showed evidence of a more or less extensive peritoneal inflammation, by the presence of a general rigidity, general tenderness, and in

*Read before the New York Surgical Society, Oct. 26, 1910.

(*Reprinted from the Annals of Surgery, Vol. LIII, p. 146, January,* 1911.)

Digitized by Google

four cases, by dullnss in both flanks. Seven cases were considered seriously sick as judged by the pulse rate, respiration, general appearance and the abdominal signs. The remaining five, while giving evidence of very considerable toxemia, could not be classed as unfavorable cases. Only three of the whole twelve should be called desperate cases. The findings with regard to the white blood corpuscles are interesting. The leucocytosis varied from 9,000 to 30,000 in the ten cases where it was recorded before operation, and the polyneucleosis from 73% to 96%. There was no relation whatever between the severity of the infection, as judged from general and local findings, and either the increase in total leucocytes or polynuclear leucocytes. Nor did the severity of the post-operative course seem to depend in any way upon the reactive power as shown by the leucocyte count. In the two cases, however, where the count remained close to the normal, the condition at operation was found less extensive than in the others. One man with 16,000 leucocytes and 96% polynuclear cells, made a very prompt recovery, though the intraperitoneal infection was very general. One woman having 11,000 leucocytes, with 90% polynuclear, showed a severe and general peritoneal inflammation, and made a very prompt recovery. On the other hand, a man having 24,000 white cells, 80% being polynuclear, showed no evidence of being seriously sick. At operation he showed the least peritoneal involvement of the whole series, and yet his convalescence was among the most severe.

It seems fair to conclude that, with a spreading peritonitis present, the findings as regards leucocytosis and polynucleosis are of no value in determining either the severity of the lesion, or the prognosis.

A gangrenous appendix, either in whole or part, was found to be the cause of the peritonitis in each of the twelve cases.

Digitized by Google

In ten cases, pus was found in the subhepatic pocket, the pelvis and the subsplenic pocket. That is, an infectious process existed in practically the whole of the greater peritoneal pouch. In one, the right side and the pelvis only, were involved, and in one the pus seemed to be confined only to the cecal region and the pelvic cavity.

In the latter, the post-operative course was among the most severe, though before operation the man seemed not seriously sick. In several of the cases pus was found occupying the spaces among the small intestinal coils in the umbilical region. In five cases, it is noted in the history that the peritoneal coat of the intestines seen, showed marked inflammation. In two, absence of such a condition was noted, and one of these was the most seriously sick of the whole series. In the remaining five no mention of this point is made, and this is presumptive evidence that the serosa did not show an inflamed condition.

The management of all the cases was practically the same, modification being made only to meet special indications. All were prepared by the emergency iodine method, and were operated within one hour of admission. The preparation was completed, and the sterile sheets placed before anæsthesia was begun, and this was produced by nitrous oxide and ether. The incision was made over the mass when such existed, and when not felt it was made at the usual site. The appendix was removed by simple section at the base after ligation, and the stump was cauterized with carbolic acid and alcohol. Burial of the stump was not practiced because the conditions were not favorable and the time required is a distinct loss to the patient. The presence of pus was then determined in the pelvis, and the right flank, by means of a gauze sponge. If found, the table was elevated to an angle of 15 degrees with the head up. The return flow syphon tube devised by Blake was con-

Digitized by Google

nected with an irrigator of hot normal saline solution, and after the flow was established filling the tube, the flow was temporarily stopped, and the tube introduced along the anterior abdominal parietes and then downward to the pelvic floor.

The syphonage immediately started, and the saline mixed with pus promptly flowed from the exit. This was continued until the water returned clear. The tube was then cautiously introduced in the same manner into the left mesenteric gutter, and if the return flow showed pus, the procedure was continued until that part was clean. The right gutter was then attached, and if necessary, the coils of intestine in the mid-abdominal position. These procedures always resulted in the washing of some pus into the pelvis, and this was therefore again washed out. In one case, about sixteen gallons of solution were required to complete the washing, and in many, six or eight gallons were used.

This washing requires some practice to get the best results; the height of the irrigator; the length of the outflow syphon tube; the slant of the table and the position of the solid tube all needing some slight modifications in individual cases.

Another point of importance is that the edge of the wound shall be held snugly around the tube so that a return flow does not take place along it instead of through the syphon.

If care be exercised, the separate pockets holding the pus can be emptied with practically no soiling of the non-affected parts, and at the conclusion the operator feels comfortably sure that no free pus remains in the peritoneum. The procedure is attended with practically no shock. The time consumed is from three to ten minutes. A drain, usually a cigarette, is passed into the pelvis, and if necrotic tissue exists around the cecum, a second one at that point. The abdominal wound is

Digitized by Google

sutured enough to guard against intestinal prolapse, and a dressing applied.

The whole operation, in cases where no difficulty was encountered in getting the appendix out, occupied less than fifteen minutes, and the usual time was from twelve to twenty minutes.

At the close of the operation a lavage was done, unless it had been done for special reasons previously, and the patient was put to bed with the head and shoulders elevated, either by raising the whole bed, or by using a bed rest, this being determined by which position was the more comfortable for the individual patient.

The contrast between many of these patients immediately before operation, and on their return to consciousness from anæsthesia, was marked. The abdomen changed from a condition of board-like rigidity, to a normal relaxed state, and except over the wound, showed no tenderness to palpation. The evidence of suffering had often entirely disappeared, and it was not an unusual thing to hear the patient say he felt quite well within a few hours.

The after treatment was as follows: Enteroclysis by the deep method was established, and continued for several hours, remitting it when the colon showed any evidence of intolerance, or became overfilled. Lavage was done when vomiting was troublesome, or when gastric distention was present, often being repeated three or four times in the day. Nothing was given by mouth for twenty-four hours. Morphine, hypodermically, was given sparingly if the pain recurred severely.

If the distention became at all marked, turpentine stupes were given, the wound being protected by rubber tissue and chloroform, and these were supplemented by turpentine, oil, oxgall or epsom salts enemata, or combinations of them.

Digitized by Google

Nourishment was withheld until it was demonstrated that intestinal paresis need not be feared. In one or two cases this covered a period of four days. The first nourishment was in the form of small amounts of broth and albumen water. If this was well borne, the quantity was gradually increased, and then other easily digested articles were added, milk being withheld until the bowels were moving well and distention was absent. Cathartics were used sparingly, and usually not given until after forty-eight hours.

As soon as the digestive functions became normal, the diet was increased gradually, and then given liberally to repair the loss of strength.

The drain was usually loosened at about thirty-six hours after operation, and then was gradually drawn out and shortened. After four days, it consisted, as a rule, of only a drain for the parietes.

Results.—All the patients recovered. Two developed a small patch of pneumonia, and one a left sided phlebitis in the femoral vein. The remaining nine had no complications. No fecal fistula developed, and no secondary abscesses. The patients left the wards to return for wound dressings, in from ten to thirty days, four being discharged in less than two weeks, and four others in less than three weeks, the longest period being thirty-four days. Many of them, including those who showed a temporary cessation of pain and distention immediately after the operation, again suffered from these and there was no evident relation between these and the severity of the condition found at operation.

The most severe case in the series, a woman who remained in a precarious condition for six days, had neither, while the least extensive case (the pelvis alone was involved) and one of the least sick before operation, suffered severely from both

Digitized by Google

for nearly a week, but his general condition remained excellent. Twelve cases is too few to establish any advantage of the treatment used here over other methods, but the results are sufficiently promising to have this general method tried. It is in no particular a new method, but is presented as an added link in favor of the cleansing of the peritoneum as against leaving the contained pus to be taken care of by the patient.

Digitized by Google

Digitized by Google

XXV.

ACUTE ULCER PERITONITIS IN TYPHOID FEVER.*

A PLEA FOR ITS EARLIER RECOGNITION.

By Forbes Hawkes, M. D., Associate Visiting Surgeon.

It is well established that patients suffering from so-called "intestinal perforation" in typhoid fever should be treated surgically. A surgeon's percentage of recoveries following operation for this condition will depend to a very great extent upon the number of hours that have elapsed between the time of the peritoneal invasion by the ulcer and the time when the patient is placed upon the operating table. This period will have to be shortened if the mortality records of this complication are to be improved.

It seems wise to put to ourselves frankly the question, Can we diagnose typhoid ulcer peritonitis at an earlier stage than is now the rule? If we feel that this cannot be done with the present means at our disposal, further attempts to shorten this period will have to be along executive rather than diagnostic lines. The writer believes, however, that in a great many cases an earlier diagnosis can and should be made, and that better methods should be adopted in order to give to the patient the full benefit of such an earlier diagnosis.

The general use of the word "perforation" in this connection has been extremely unfortunate, for it has unquestionably

*Read before the New York Surgical Society, February 8, 1911.

(*Reprinted from Annals of Surgery, May,* 1911).

Digitized by Google

led the physician to disregard the changes which have preceded this event in his typhoid patients. Fixing his attention rather on the symptoms which may accompany or follow such an occurrence, which after all is often only the chance termination of an inflammatory condition which should have been recognized long before, he has in many cases allowed the preceding condition to progress undiagnosed, to the great detriment of his patients. Even in the fatal cases of ulcer peritonitis, a true perforation, such as one sees in gastric ulcer, does not invariably occur. When it does it is often only as a last nail driven into the patient's coffin. It has been preceded almost without exception by signs of the greatest diagnostic value.

From his operative experience the writer believes that in the cases where the ulcer is not confining itself to the mucous layer of the bowel the progressive changes that occur are usually as follows:

(*a*) *A distinct invasion of the muscular coat of the bowel.* While theoretically a slight invasion of the muscularis without any resultant affection of the overlying peritoneum is possible, it seems probable that this is a very rare occurrence.

As soon as the ulcer has gotten well into the muscularis and the inflammation has invaded its layers, (*b*) the overlying peritoneum becomes distinctly involved; we then have a *clinical peritonitis.*

This earliest peritonitis should be recognized at its onset. We should not wait until (*c*) *the muscularis has become necrotic* and the overlying peritoneum has become simply a thin film interposed between this necrotic tissue and the general peritoneal cavity; because by this time we shall have to diagnose in most cases (*d*) *a spreading peritonitis* either from the diffusion of the septic material in the necrotic area, or later from

Digitized by Google

the additional dissemination of the contents of the bowel, which have filtered through the broken-down base of the ulcer.

This earliest peritonitis is seen to assume two forms:

(*a*) There is produced by the peritoneum in the vicinity of the ulcer a fluid serous exudate in varying amounts, a material of protective value possibly in a mild case that is not going on to a general peritonitis; yet mechanically harmful in the others, in that it restricts localization and tends to float the coils of intestine apart, exposing large surfaces of peritoneum to the mechanical dissemination of the toxic material which is continually supplied to it as the ulcer progresses.

(*b*) The other type is the dry exudative type, in which the peritoneal surfaces in the vicinity of the ulcer are glued to the peritoneum over the ulcer, a process which helps mechanically to localize the infective material. The two types may be combined in varying degrees according to the kind of infection that is present.

The earliest stages of peritonitis in typhoid fever are recognizable in almost all cases by muscular rigidity, tenderness and pain, sometimes by muscular rigidity and tenderness alone. The physician's aim, therefore, should be to detect this first appearance of muscular abdominal rigidity, and thereby to establish a diagnosis of beginning peritonitis.

Muscular Rigidity.—From his experience in bedside instruction, both with under- and post-graduate medical students, the writer believes that this most important sign seldom receives proper attention. He is convinced that it should be recognized as the paramount sign in acute abdominal conditions, and that instructors should give to it first place in their teachings on the subject. The proper recognition of abdominal rigidity in its earliest stage may well mean life to the patient. It is true that two observers may differ as to the presence of muscular

Digitized by Google

rigidity in a given case; this has been seen by the writer on several occasions. This is due either to a poor tactile power on the part of one of the examiners, or to a faulty method of examination, or to the improper posture of the patient during the examination, or to all three of these.

When speaking here of the lighter shades of muscular rigidity reference is made to the early appearance of this tonic-reflex-muscle-contraction, not to that intense degree of general muscular abdominal rigidity which follows it and which is found in late stages of a general diffused septic peritonitis from whatever cause—in the so-called "board-like abdomen." There the rigidity present is grossly evident to any examiner the minute he puts his hand on the abdomen. It is the light shades of abdominal rigidity—those that appear at the inception of the peritoneal process—that we should be able to detect, and in order that their presence may not be overlooked the following precautions and methods should be remembered and observed:

Position of the Patient, His Surrounding, etc.—The patient should be lying out horizontally, with both knees drawn up. The position should be a comfortable one. The mouth should be slightly open, and the patient is told to breathe quietly. The arms should be at the side and extended; the head should be kept directly in the middle line and in a comfortable angle of flexion. The room in which the patient is examined should be warm, for a cool room may cause slight tremors in the abdominal muscles, which will prevent a satisfactory examination. The bladder should be empty.

The Examiner.—The examiner, whose hands have been warmed if necessary, stands on one side of the patient and first very quietly and very gently palpates with the flat of the hand those portions of the abdomen in which the patient does not complain of pain, tenderness, or discomfort, then gradu-

Digitized by Google

ally passes over to the affected parts. This gentle preliminary procedure affords to the examiner a rough idea of the general condition of the abdominal contents as to tumors, swellings, amount of adipose, points of tenderness, etc., and serves to allay a possible apprehension on the part of the patient. The next step is to determine the presence of rigidity in any of the abdominal muscles. This, in the writer's opinion, is best done with the most sensitive organs at our disposal—the finger-tips of the right hand. If the examiner is left handed, those of the left hand should of course be used. The wrist and the finger-joints are all kept slightly flexed, and a succession of short but very delicate "pushes" is made with them over the muscle that is being tested. It requires hundreds of examinations, as a rule, for the beginner to acquire the ability to detect slight differences in the amount of rigidity present in different muscles or in the various portions of the same muscle; but the acquisition of this power is well worth infinite pains and patience on his part. The two sets of muscles which should be tested with special care for rigidity in typhoid patients are the recti and the lateral abdominal muscles. Owing to the usual preponderance of the dangerous ulcers in those coils of small intestine that are commonly found in the right iliac fossa and right paraumbilical regions, the right rectus and right lateral muscles should receive first attention. Taking into account the normal differences in muscle tone between the three segments of the rectus muscle, a preponderance of rigidity in any one of the three sections of the right rectus over that found in the corresponding section of the left is first to be noted. Then a rigidity of the right lateral muscle layer is sought for as compared with the same layer on the left side.

Abdominal Tenderness.—Abdominal tenderness has been mentioned as one of the signs of beginning ulcer peritonitis.

Digitized by Google

It is usually present at an early period, and is localized to the area where the rigidity is found; it may not be marked at first in the cases where a fluid exudate separates the peritoneal surfaces in the vicinity of the progressing ulcer, but even here its appearance is seldom delayed. We cannot, of course, expect to elicit this sign very clearly in the toxæmic and comatose cases. In testing for the presence of tenderness, light pressure only should be used, otherwise adhesions may be broken up and pus and fecal material forced through the base of the ulcer.

Pain.—As a rule pain does not precede but *follows a peritonitis.* Cases operated on shortly after the appearance of pain often reveal an acute peritonitis that has undoubtedly been under way for some time before the pain began; this fact has unquestionably been the cause of delay in diagnosing a beginning peritonitis. Writers on the subject of so-called "perforation" mention pain as the prominent symptom, and most of them seem to think that a preperforative stage cannot be diagnosed because there may be no pain at such a time. It is the writer's opinion that a recognizable amount of muscular rigidity and tenderness is often present at an earlier period than pain in ulcer peritonitis, and it is this very period of earliest peritonitis that must be recognized, if the post-operative mortality records in this condition are to be improved.

Dulness in the right flank, which shifts on turning the patient on the left side, may be an early sign of such a peritonitis; the fluid being formed first in the right iliac fossa region, then gravitating towards the pelvis, and later spreading to the abdomen generally. This shifting dulness is a very valuable sign if present at an early period. A *rising blood-pressure* and a *rising leucocytosis* may be of help in a doubtful case. Both may be absent, however, in the early stage of a peritonitis.

Digitized by Google

Differential Diagnosis.

Should rigidity of the paraumbilical part of the right rectus muscle be found, or of the lateral muscles just external to it, especially if it be associated with a tenderness which has not previously been present, a diagnosis of beginning peritonitis in the right iliac fossa is assumed.

A differential diagnosis is then to be considered between *"beginning typhoid ulcer peritonitis"* and *"beginning appendix peritonitis."* Unless the patient's appendix has been removed this is sometimes difficult. Fortunately, however, such differential diagnosis is not usually of vital importance, because a typhoid appendicitis which has progressed to the extent that it is associated with peritonitis (peri-appendicitis) should instantly be followed by the removal of the appendix. Should there be doubt it is safer to act as though the condition were one of ulcer peritonitis.

The differential diagnosis between an acute ulcer peritonitis and a sudden and copious *intra-intestinal hemorrhage* in typhoid fever is usually an easy one. In intra-intestinal hemorrhage without an accompanying acute peritonitis, there is no muscular rigidity. The patient may complain of pain, but often there is none at first. If the hemorrhage is at all extensive, there is apt to be a sudden drop in the temperature, with a marked elevation of the pulse-rate, and the patient's color becomes distinctly paler. It is very rare to have both acute peritonitis and hemorrhage occurring simultaneously, but a peritonitis will frequently occur a few days after a hemorrhage, from further progress of the ulcer. In the earliest stages of an acute ulcer peritonitis little or no change can be noted in the previous pulse-rate or in the temperature or respiration, but there is always some discoverable muscular rigidity, and usually some tenderness. If the patient is so comatose from

Digitized by Google

a co-existent typhoid sepsis as to be unresponsive to the palpation of the abdomen, it will be difficulty to judge the degree of tenderness present.

It is the writer's opinion that in a great many of the cases of intestinal hemorrhage in typhoid fever there co-exists a certain amount of low-grade peritonitis, which may at any time suddenly take on the characteristics of an acute process when the ulcer from which the hemorrhage has occurred has increased in depth or in extent. A recognizable amount of muscular rigidity should be present when this event has taken place.

When, during typhoid fever, there occurs an *acute cholecystitis* which progresses until there is an affection of the peritoneal covering of the gall-bladder, rigidity of the overlying right rectus muscle in its upper third will be present, with tenderness over the gall-bladder region. If it is a primary attack and the stomach, transverse colon, or omentum has not as yet become agglutinated by peritoneal adhesions to the gall-bladder, there may be no mass to be felt. As the peritonitis extends, rigidity of the lateral abdominal muscles in the right iliocostal space will be easily recognizable. A peritonitis from a typhoid ulcer located either in the hepatic flexure or in the upper part of the ascending colon should, however, be kept in mind where rigidity in the right upper quadrant is encountered.

A *right lower lobe pneumonia* or a *right-sided pleurisy* will often be associated with rigidity of the upper part of the right rectus and of the right lateral (iliocostal) muscles. Careful thoracic auscultation should determine such a diagnosis. Diminished breathing may be the only sign at first.

An *extensive infarct or inflammation of the spleen* will be accompanied by rigidity of the left upper rectus and lateral iliocostal muscles and by local tenderness, imitating the *kidney*

Digitized by Google

infarcts and perinephritis in this particular. So will peritonitis about a typhoid ulcer in the splenic flexure of the colon. If there is no blood or pus in the urine a positive differential diagnosis may not be easy.

A typhoid patient who has fallen out of bed may suffer a contusion of the abdominal muscles. In such a case co-existing contusions of the skin or subcutaneous ecchymoses over prominent bony points are likely to be present. If found they should make us suspicious of an occurrence of this kind.

A *hemorrhage into one of the abdominal muscles* may occur, associated with a degeneration of the muscular fibres (Zenker's degeneration). The localized hemorrhage usually presents a raised or softened area in the muscle, differing in this way from a condition of muscular rigidity.

Tenderness in the suprapubic region should direct our attention to the possibility of a *distended bladder*. If unable to pass a sufficient amount of urine, the patient should be catheterized. Muscular rigidity present after this in the lower segments of the recti should make us suspicious of a peritonitis, either from an ulcer situated in a pelvic loop of intestine (small or sigmoid) or from a pelvic appendix. In women a vaginal examination should be made to clear up possible uterine or adnexal disease. A rectal examination here may be of distinct help.

A *soft tympanites* occurring during typhoid fever should be carefully watched. If it becomes a *hard tympanites* the muscular rigidity then present will indicate that there co-exists a certain amount of scattered peritonitis, probably from multiple ulcers. The writer has seen this condition in several toxic cases where the toxæmia had so overwhelmed the patient that the existence of pain and the presence of tenderness could not be ascertained; operation had therefore not been suggested. The

Digitized by Google

autopsy showed areas of peritonitis mostly in the right side of the abdomen, apparently from the ulcers. A *periostitis of one of the ribs* that form the lower costal border may be associated with some rigidity of the abdominal muscles attached to that rib. Here localized tenderness at first over the affected rib should make the diagnosis clear if later there should be swelling.

An acute attack of *renal or ureteral colic* may come on during the progress of a typhoid fever. The great rarity of this complication is probably due to the fact that the typhoid patient is usually quiet in bed and that existing calculi are therefore subjected to little or no jarring. During the acute period of the attack there is usually some rigidity of all of the muscles on the right side. The history of a previous attack and the presence of blood in the urine would be of help. A radiograph might confirm such a diagnosis.

A *peritonitis from a mesenteric gland* that is on the point of suppuration cannot usually be distinguished from a beginning ulcer peritonitis, for they may both be present in the same case from the same infection.

From the foregoing it will be seen how important becomes the determination of even the lightest form of muscular rigidity, and how valuable to the patient may be the examiner's ability to accurately locate such rigidity in one of the quadrants of the abdomen. Such a beginning peritonitis may not last as a moderate process for more than a few hours; its duration as such may even be shorter than this, hence abdominal examinations of all typhoid patients between the third and sixth week of their disease should be made by a *competent trained diagnostician* at intervals of a few hours if the existence of such a beginning peritonitis is to be discovered.

Digitized by Google

This may seem not to be a feasible procedure. Before discussing its feasibility let us consider the conditions which usually surround typhoid patients at the present time in what is often regarded as an almost ideal place for them, namely, the "typhoid ward" of any of the larger city hospitals. They are there under the supervision of an eminent attending physician with a picked staff of medical internes and a corps of energetic and experienced nurses.

During the hours from 8 A. M. to 8 P. M., such a ward will be visited once, possibly twice, by the attending physician, who will devote considerable time to the typhoid patients. At other times during these twelve hours there will probably be some one member of the interne staff coming and going in the ward a good part of the time, so that any change which he or a nurse may notice in the condition of any one of the typhoid patients will be immediately reported to the house physician, or to the next member of the interne staff if the house physician is otherwise occupied. The patient is then carefully examined.

If there has been a complaint of abdominal pain and the examination reveals a change in the patient's appearance, with marked muscular rigidity and tenderness, the house physician, suspecting so-called "perforation," is apt to seek a confirmation from his attending physician. If by good fortune he can be located and can leave his work and hurry to the hospital, the delay will probably not be a long one. If the diagnosis be confirmed and the same good fortune attend the location of one of the attending surgeons, the total delay may not amount to more than a few hours. There is apt to be greater delay than this, however, and it is a fact that operations on so-called "perforating cases" are seldom done in so short a time.

Digitized by Google

Especially is this the case when the peritonitis has started at night.

At night the nursing staff is reduced and even if special nurses are in constant attendance on the typhoids a slight change in a patient's condition associated with a light degree of abdominal discomfort or pain is not so readily noticed as in the daytime. This is apt to cause a delay in securing a visit of the medical interne on night duty. This is especially true between the hours of 12 M. and 7 A. M. By the time the attending physician has seen the patient and the surgeon has confirmed the latter's diagnosis and the patient is placed on the operating table, several valuable hours have probably been consumed. If we add to this the time that has elapsed between the beginning of the peritonitis and the first distinct complaint of abdominal pain on the part of the patient we shall often have a delay of at least six to eight hours before operative measures are instituted, and when the peritoneum is opened it is usually found full of pus.

What is the remedy for all this? First, a skilled *resident* (salaried?) *physician* with previous ample experience in a large general hospital; second, a skilled *resident* (salaried?) *surgeon* of equal surgical experience who can reach the bedside day or night in a few minutes; third, "a special night typhoid service," consisting of rounds made to all waking typhoid patients (both ward and private) every two hours, from 8 P. M. to 8 A. M. by those members of the interne staff who have had previous experience in diagnosing acute surgical abdominal diseases and who will therefore be on the lookout for the earliest evidences of muscular rigidity. In this way any waking typhoid who *on inquiry* complains of the least degree of discomfort in the abdomen may be carefully examined. If muscular rigidity or tenderness be present, the resi-

Digitized by Google

dent physician can immediately be notified and within a few minutes the resident house surgeon may also be at the bedside; if the condition be judged one of beginning acute ulcer peritonitis, another twenty minutes should be sufficient to have the operating room ready. In this way the operation may be undertaken by the resident surgeon within one or two hours from the time when the peritonitis has started. Consent to operation should be obtained and recorded on admission in every case where symptoms are present suggestive of typhoid fever. Delay is thus avoided at a time when every minute counts.

In outside practice what can be done along these lines? It seems to the writer that in the case of well-to-do patients the practitioner will wisely secure the bedside attention of two recent hospital graduates, one for day duty (12 hours) and the other for night duty (12 hours), from the beginning of the third week of the disease. Under these circumstances the graduate who keeps constantly in mind the first signs of an ulcer peritonitis can, at the very first complaint on the part of the patient of any abdominal discomfort, examine the abdomen and if muscular rigidity be present summon the practitioner to confirm the diagnosis. The practitioner will have previously made out a list of the surgeons (probably three at least) who upon inquiry have expressed to him the likelihood that they will be available during these three or four weeks and within reach by telephone. He will then immediately call on one of these surgeons to confirm his diagnosis and to operate within the hour if such is the decision. In any of the larger cities this forestalling should be possible with such surroundings, and it seems probable that in this way an operation could usually be started within two hours of the first signs of peritonitis. In non-toxæmic cases the chances of such patients to recover from this complication should be at least 50 per cent.

Digitized by Google

In outside practice where few patients can afford such skilled attention, and especially in the country districts, it is doubtful whether the present mortality percentage in typhoid ulcer peritonitis can be much reduced, unless the nurse in charge be able to detect the early stages of abdominal rigidity. Without going into the general theme of instruction to nurses, the writer feels that they should have special instruction in this subject. Such a practical course could be included in the one on surgical emergencies. While their training does not aim to qualify them to make accurate differential diagnosis in acute abdominal diseases, still it is fair to presume that after such practical instruction they should be able to ascertain the presence of muscular rigidity and its location. The importance of this subject is so great that superintendents of training schools may well give it their earnest consideration.

It may, of course, occasionally happen that the practitioner will be making his daily visit during or a short time after the first appearance of such peritoneal change, and that a surgeon can reach the case soon afterwards, but this must inevitably be the exception. One would say, therefore, that the ideal place at the present time for a typhoid patient would be in the general or private wards of a large medical and surgical hospital, where such skilled attention as the writer has previously mentioned can be secured.

It has been estimated that so-called "typhoid perforation" has been the cause of 25,000 deaths annually in the United States.

Operative Considerations.

Given the presence of a light degree of muscular rigidity and tenderness in the right iliac fossa or right paraumbilical region, are we justified in advising operation?

Digitized by Google

The writer believes that operation is here indicated for the following reasons: In most of the cases a beginning ulcer peritonitis will be found. If the more common variety, the fluid exudative type, be found, this may by properly placed drainage be either arrested or converted into the dry type. The relief of tension will favorably influence the inflammatory process about the ulcer or ulcers, stopping it entirely where it is of mild type (Case IX), or preventing the development of pus in the moderately severe cases (Case VIII) or helping to localize it in the more severe ones (Case VII), so that in the latter it will either discharge itself later through the drainage tract or be accessible for subsequent evacuation.

If the necrotic process be found to have already invaded the peritoneal layer over the ulcer, a covering over of this area by suture, with or without omental grafting as the case may be, will be in order; or simple drainage may be used.

Washing out the peritoneal cavity in this early period does not seem to be advisable. In those very rapidly progressing cases, however, which are fortunately of unusual occurrence, where the bowel contents have escaped at an early period into the general peritoneal cavity from the giving way of the necrotic base of the ulcer, their removal by flushing is indicated. Here pelvic drainage also will usually be provided. If on opening the abdomen an acute appendicitis be found, an appendicectomy should immediately be done, but here also search should be made for ulcer peritonitis, for an associated secondary peri-appendicitis of a marked type, from extension, may well exist alongside of an ulcer peritonitis. Local or general anæsthesia will be used according to the operator's judgment. The assumption of Fowler's position after operation seems of distinct help. It is a noteworthy fact that a very large number of the non-toxic cases who have been subjected to an

Digitized by Google

early exploratory operation for a "suspected perforation," and in whom peritonitis has been found but no perforation, have recovered. The writer's belief is that in many of these, even where no drainage was used, the opening of the peritoneal cavity with the necessary handling of the intestines either arrested the peritonitis or changed its type so that the local conditions about the ulcers were favorably influenced and perforation averted. In cases where there has been an intestinal hemorrhage the probability of a supervening peritonitis should constantly be kept in mind. Examinations in these cases should be made certainly as often as every two hours if the patients are awake, in order to discover the earliest appearance of muscular rigidity in the right iliac fossa. Should it appear, the advisability of doing an exploratory operation for the peritonitis should be very seriously considered. The writer is willing to go a little further and the suggestion is here made that such exploratory laparotomy may not only influence the peritonitis in a favorable manner, but by so doing secondarily hinder the further destruction of the blood-vessels in the ulcer base, and avert hemorrhage. While a recommendation of this kind would not seem to be justified unless there exists a very distinct amount of rigidity in the right iliac fossa, the presence of the latter would make the procedure seem eminently proper.

It is worthy of note that the cases who have had intestinal hemorrhages followed by ulcer peritonitis with or without perforation, and who have been operated upon and recovered, have rarely had any subsequent hemorrhages.

CASE IX. S. D., colored, aged twenty, was admitted to the Presbyterian Hospital on Nov. 25, 1906, in about her fourth week of typhoid. She was apathetic and at times comatose. General tremor was marked, so much so that the taking of the pulse at the wrist was almost impossible—a markedly toxæmic case. About 12 M., November 28, 1906, her pulse which had been about

Digitized by Google

120 had become much more rapid. When the writer was called to see her about ten hours later he found that the heart-beats were 160 to the minute, that her abdomen was markedly rigid over the right iliac fossa, and that there was moderate rigidity in the right flank. There was slight dulness in both flanks. On account of her apathetic condition it was hard to judge the amount of tenderness that was present. A diagnosis was made of ulcer peritonitis and consent for operation then obtained from her husband. Operation was done on Nov. 29, 1906, at 12.30 P. M. On account of a suspicion of pneumonia cocaine was used. The mixed form of peritonitis was found, the peritoneum being œdematous in places with the fluid exudate, in places dry with an adhesive peritonitis; the appendix was normal except for its peritoneum. About one-half inch from the ileocæcal valve in the small intestine there was an indurated patch representing the site of an ulcer which had not gone on to perforation. The vessels over this patch and for some distance from it were tortuous, congested, and of a bright crimson color. Three similar areas were found further up in the small intestine, and about four inches apart. There were some large and inflamed mesenteric glands. The pelvic contents were normal. A gauze and rubber tissue cigarette drain was placed to the site of the ulcers. The operation was followed by distinct improvement in the quality of the pulse and in the patient's general condition. The abdominal rigidity entirely disappeared. Her toxæmia became still more marked, however, and about the third day after her operation the signs of a double pneumonia were distinct. She died. The autopsy showed that there was no perforation and that the peritonitis had subsided. There were only a few fine adhesions alongside of the drain.

In this case proper drainage was followed by the entire subsidence of the peritonitis. Had there not been so much toxæmia it is fair to presume that this patient would have recovered.

CASE VIII.—G. B., chauffeur, aged thirty-nine, was admitted to the Presbyterian Hospital on Oct. 29, 1906. On Nov. 8 and 9, the patient being in about the third week of his typhoid, several hemorrhages had occurred. Thirteen ounces of blood were passed. About eight o'clock the next morning, he complained of some discomfort, followed by pain, in the epigastrium. This shifted in the course of the hour to the right iliac fossa. He was seen by the writer about an hour later, when distinct abdominal rigidity was found all over the right side; there was also some rigidity on the left side. The paraumbilical portion of the right rectus exhibited the greatest rigidity. Tenderness in the right iliac fossa was just appreciable to the lightest form of pressure. There was shifting dulness in both flanks. The pulse was about 120 (there had been little change in it). A diagnosis was made of pre-perforative ulcer peritonitis and immediate operation advised. Laparotomy was done about one and one-half hours after the beginning of the abdominal pain. The abdominal cavity contained more than a pint of clear serum, most of it in the right iliac fossa. In the small intestine, about six inches from the ileocæcal

Digitized by Google

valve, there was a thickened area, with crimson peritoneal surface, the site of an ulcer. The loops of intestine in the right iliac fossa were all congested, but no perforation was found; the appendix was normal. The mesenteric glands were enlarged and congested. A gauze and rubber tissue cigarette drain was placed to the ulcer site. The patient made an uneventful recovery.

This patient had more than a pint of free serum in his abdominal cavity from ulcer peritonitis about one and one-half hours after his first complaint of abdominal discomfort, and he had very marked abdominal rigidity by the time this discomfort had become actual pain. Appreciable rigidity had undoubtedly been present before this. Here also proper drainage was sufficient to effect a cure.

CASE VII. E. G., aged thirteen, school girl, came to the Presbyterian Hospital suffering from a relapsing typhoid on January 5, 1906. For the following nine days she had run a fairly typical typhoid course. There had been some abdominal distention, but no rigidity had been noted. She had taken her baths and nourishment well. There had been a positive Widal reaction on January 11. On January 14, about 4 A. M. (the abdominal distention having become more marked during the night), she had had a severe chill and her temperature had risen to 104.6° F., her pulse-rate to 132, and she had complained of pain in the lower abdomen. This localized itself shortly in the right iliac fossa. The writer was called to see her about 9 A. M. (five hours after her chill). Her abdomen at that time was markedly rigid over all, the right rectus distinctly more so than the left. There was a free fluid wave across the abdomen. Extreme tenderness was present with marked distention. There was very little respiratory movement in the abdomen. A diagnosis was made of spreading peritonitis, probably from a perforating typhoid ulcer. Operation was undertaken in a few minutes. Free seropurulent fluid in large quantities was found in the general peritoneal cavity, with scattered particles of lymph. On one of the intestinal loops there were several patches which looked as if they were about to break down, and one patch which was perforating in the centre; from this fæces exuded when the loop was handled. A purse-string suture of silk was placed around this patch and over it a continuous Lembert. A high pillow was placed under the shoulders to allow the free fluid to gravitate into the pelvis, and a flushing of the pelvis was then carried out with hot salt solution. A long gauze and rubber tissue cigarette drain was placed to the bottom of the pelvis. Fowler's position was used for several days. The patient went on to complete recovery, the resulting fecal fistula closing in a few weeks.

In this case the findings at operation justified the conclusion that some peritonitis had existed for several hours before the acute attack began. The chill and marked rise of temperature and of pulse-rate, with the pain in the lower abdomen, undoubtedly represented the change from a serous to a purulent exudate. The writer feels that this occurrence might have been avoided by a prompt laparotomy done at the earliest appearance of abdominal rigidity.

Digitized by Google

CASE XI.—S. S., aged twenty-one, clerk? was admitted to the Presbyterian Hospital on Aug. 31, 1909, apparently in the end of his second week of typhoid. On Sept. 9, about 10 A. M., he complained of pain across his abdomen, and his appearance became somewhat changed. His temperature rose to 105° F. and his pulse-rate to 108. He vomited several times. A little after 4 P. M. he was seen by a surgeon who was reported to have been unable to detect any abdominal rigidity and on this account had advised against operation. The writer saw him within three-quarters of an hour from this time and found very marked muscular rigidity over the whole abdomen, with shifting dulness in the flanks and general tenderness. A diagnosis was made of an extensive peritonitis, probably from typhoid ulcers. The patient was operated upon about twenty minutes later. Free gas was found in the right iliac fossa, and the peritoneal cavity generally was filled with greenish-yellow ropy pus. On a loop of small intestine, about six inches from the ileocæcal valve was found an indurated area, of about the size of a twenty-five cent piece, with a small perforation in its centre. The peritoneal surface of this area was greenish yellow in color, and on a neighboring coil of small intestine was seen a peritoneal plaque of the same size and color, representing apparently the part where this adjacent coil had been in contact with the ulcer area. Several Lembert sutures were applied, folding in the ulcer area. Drains were placed as follows: one of plain gauze to the right iliac fossa close to, but not touching, the line of Lembert sutures; two others to the bottom of the pelvis (one being a gauze and rubber tissue cigarette drain, the other a split rubber drainage tube which contained gauze). The patient had been placed with the shoulders elevated as soon as the peritoneal cavity was opened. After the operation Fowler's position was continued for several days. A small fecal fistula formed which soon closed. A slow but satisfactory recovery followed.

In this case operation was done about seven and one-half hours after the beginning of the acute symptoms. The writer is convinced that an appreciable amount of abdominal rigidity was present at the time of the acute onset, and probably for an hour or so before this. By an earlier operation the suppurative process might have been averted.

The following seven additional cases are here reported, making with the previous four a total of eleven operated upon by the writer for acute ulcer peritonitis in typhoid fever. Of these eleven, three recovered and eight died, a mortality per cent. of 73. If the three toxæmic cases (Cases II, IX, and X) are excluded from this list, it will then show eight cases with five deaths, a mortality percentage of 62.5. While almost all of the markedly toxæmic cases die of their toxæmia, whether operation be done or not, it does not seem fair to withhold operation from such of them as exhibit the slightest signs of ulcer peritonitis; for they may thus be helped to overcome this extra tax upon their resistance. Local anæsthesia would seem best for the operation

Digitized by Google

in these cases, and the shock of simply opening the abdomen and inserting a proper drain to the right iliac fossa should be slight.

CASE I. C. H., clerk, aged twenty-four, was admitted to the Presbyterian Hospital on Oct. 5, 1900, with a diagnosis of typhoid fever. He ran an average typhoid course during the following five days. The writer was called to see this patient about 10 P. M., Oct. 11. He had then been suffering from abdominal symptoms for over twenty-four hours. They had consisted of continuous abdominal pain, hiccoughing, and distention. At 11 P. M., Oct. 11, his condition was as follows: He had marked abdominal rigidity, some distention, and his pulse was of poor quality. His general appearance was bad. A diagnosis was made of intestinal perforation with general septic peritonitis, and operation immediately undertaken. It revealed a general peritonitis with much purulent fluid and fibrinous flakes. There was free fecal material in the peritoneal cavity. About one foot from the ileocecal valve was a perforation of the size of an ordinary lead pencil, through which fæces were issuing. The ragged edges were trimmed hastily with scissors and two layers of Lembert sutures applied. There were a number of other ulcer patches which had not perforated. The peritoneal cavity was irrigated with several gallons of normal salt solution and drains placed to the pelvis. In spite of acute stimulation the patient died about five hours after the operation.

CASE II. G. McO., aged thirty-one, was admitted to the Presbyterian Hospital, on Aug. 15, 1903, with a ten-days' history of malaise and of slight abdominal pain, chiefly in the right iliac fossa. He went through a fairly typical typhoid attack, and his temperature became normal on September 6; he then had a relapse and in a few days became actively delirious and distinctly toxæmic. On Sept. 20, early in the morning he had a chill and his temperature rose to 106° F. His leucocytes were 4200. At 4 P. M. his abdomen had become very tense, and peritoneal friction râles were heard over its upper part. At 5 P. M. his leucocytes were 3500. At 8 P. M. his leucocytes were 3900 and the abdominal condition had become still more marked. At midnight his condition had become desperate. The writer was called in to see him at this time and found his abdomen markedly rigid over all, distended, and the signs of free fluid and gas. Diagnosis was made of a general septic peritonitis from perforated typhoid ulcer. Operation at midnight, Sept. 20, about eighteen hours from the beginning of his symptoms. The general peritoneal cavity was full of pus and purulent serum. There were no adhesions. About twelve inches from the ileocæcal valve there was a perforation in the small intestine, from which grayish fecal matter was issuing. There were several other patches about to break down. Lembert sutures were placed on all these and the peritoneal cavity irrigated with salt solution. Drainage was used. Intravenous infusion was done during the operation on account of the patient's desperate condition. He died the next day.

CASE III.—W. K., aged twenty-one, designer, was admitted to the Presbyterian Hospital on Sept. 17, 1904, with a history of fever and headache for

Digitized by Google

about a week. He ran a typhoid course, responding well to his treatment. About 1 P. M., Sept. 22, he complained of severe abdominal pains, and his abdomen became very rigid, especially in the lower part. Later the rigidity and tenderness became still more marked, and he passed into a state of general collapse. The writer was called to see him about 6 P. M. His condition at that time was as follows: there was general abdominal rigidity, very marked tenderness over all, and a pulse of poor quality. His appearance was alarming. A diagnosis was made of general peritonitis from perforated typhoid ulcer. At the operation which was done about five and three-quarter hours after his attack of severe pain, a general peritonitis was found with much turbid fluid and pus; there was a perforation in the small intestine about eighteen inches from the ileocæcal valve; there was some fibrinous exudate about the ulcer area. Two layers of Lembert sutures were placed, and the general peritoneal cavity was flushed with hot saline. Cigarette drainage was used. During the operation an intravenous infusion had to be resorted to. Active stimulation was continued and he rallied from the operation, but died in about six hours.

CASE IV. M. M., aged nineteen, was admitted to the Presbyterian Hospital on September 27, 1904, with a fairly typical typhoid history. He had in addition complained of some pain in the centre of his abdomen. On September 29, at 9 P. M., he complained of pain in the right iliac fossa and there was tenderness there. At 11 P. M. his pain had increased. In the records there is a statement that there was slight rigidity at that time. At 12.10 A. M. there was sudden severe pain in the right iliac fossa and general tenderness and rigidity, with slight distention. Operation was decided upon, but consent was not obtained until about 4 A. M. Operation was done at 4.10 A. M., September 30, about seven and a half hours after the beginning of his acute symptoms. Free brownish fluid with fecal odor was found in the peritoneal cavity. There was also some gas. About 12 inches from the ileocæcal valve there was a perforation in the small intestine about three-eighths of an inch in diameter. The peritoneum was irrigated with normal salt solution and two cigarette drains were inserted. On account of his desperate condition the patient received an intravenous infusion, while on the operating table. Following the operation he rallied for a time, but the peritonitis did not subside and he died within 48 hours of the operation.

CASE V. S. R., aged fourteen, school girl. Her previous history was negative except for an interval appendicectomy done several years before. She was seen by the writer on October 5, 1905. She had then been running a typhoid course for forty-seven days with high temperatures and a high pulse-rate. Two weeks previously she had had a sudden attack in which the pulse was increased in frequency and in which there was abdominal pain followed by distention; since then she had had a number of these attacks which lasted about six hours. Perforation had been considered, but her attending physician thought that the indications were not sufficiently plain

Digitized by Google

for operation. About 8 P. M., October 5, she had another attack decidedly more severe in character, and there developed general abdominal rigidity. The writer was sent for at 11 P. M. and reached her home in the country at 1 A. M. Her condition at that time was as follows: There was an anxious expression to the face, marked anæmia, and a pulse-rate of about 170, weak and irregular. The abdomen was distended. The right rectus muscle was rigid throughout, and there was extreme tenderness over the right iliac fossa. There was dullness in both flanks, and a suggestion of a fluid wave across the abdomen. Diagnosis was made of repeated perforations. Operation was done about 1.30 A. M. under cocaine anæsthesia. Scattered throughout the right side of the abdomen were a number of pockets containing pus which differed somewhat in color and consistency in the different pockets. In the region of the ileocæcal valve there was a large collection of pus; there was also much pus in the pelvis. It was hard to make out the distance of the various ulcers from the ileocæcal valve on account of the adhesions. Cigarette drains were introduced to the pelvis and to the right iliac fossa. The patient's condition improved somewhat after the operation, but later in the morning her heart action became still more rapid and she died within a few hours.

CASE VI. J. P., aged twenty, was admitted to the Presbyterian Hospital on October 25, 1905, in the middle of a well-developed typhoid. From the time of admission until October 24, the fever ran a rather irregular course, due perhaps to some small intestinal hemorrhages that occurred. On October 24, about 1 A. M., the paient complained of a severe pain in the lower abdomen which lasted for a few minutes; this recurred at 3 A. M. At 8 A. M. the existence of a considerable amount of abdominal rigidity was noticed, associated with marked tenderness. Up to that time there had been little or no change in the temperature, pulse-rate, or respiration. The leucocyte count remained about the same. The writer was called to see the patient about 10 A. M. He was then in a very poor condition, with intense rigidity of all the abdominal muscles. There was some dullness in both flanks; his pulse was of poor quality, and he was somewhat cyanotic. Operation was done at 10.30 A. M., at least nine and a half hours after the beginning of his acute symptoms. The peritoneal cavity was found full of grayish fluid, and there was a general peritonitis. Six ulcers were found in the small intestine within three feet of the ileocæcal valve, all of them about to perforate except one which had already perforated and from which pus and gas escaped. Circular sutures were placed, re-enforced by Lembert sutures, and the peritoneum flushed with salt solution. A cigarette drain was placed to the pelvis. The patient died shortly after the operation.

CASE X. A. H., aged thirty. This patient was in his fourth week of a severe typhoid. His pulse-rate had been about 120, and his temperature about 104° F. He had been distinctly toxæmic from the start. His bronchitis had been severe and there had been marked congestion at the bases of both lungs. There had been three intestinal hemorrhages, one of about fourteen ounces,

Digitized by Google

the other two smaller. He had rallied fairly well from these. On April 16, about 9 A. M., he had a chill and went into collapse, the pulse being almost imperceptible and the temperature 106.2° F. Marked distention set in. The writer was called about 10 A. M., and reached the bedside about 11, prepared to operate. The patient's condition at that time was as follows: He was comatose (but could be slightly roused), and cyanotic. His pulse-rate was about 140. It was soft and weak. There was abdominal rigidity over all, the muscles on the right side being distinctly more rigid than those on the left. The whole right side was dull. There was evidently some tenderness in the right iliac fossa. Operation was done a few minutes later under eucaine anæsthesia. A quart or more of turbid, foul-smelling fluid was found in the general cavity. About sixteen inches from the ileocæcal valve were two perforations, and adjoining these were several other circumscribed ulcer areas of dark color. Fecal matter was oozing through the perforations. There were many mesenteric glands in a condition of acute inflammation. The perforations were covered in by Lembert sutures and two cigarette drains were placed, one to the pelvis, the other to the right iliac fossa. The patient stood his operation fairly well, but coma gradually deepened and he died about five o'clock the same afternoon.

A critical review of these cases brings out the fact that in the great majority of them a sufficient amount of importance had not been attached to the change in their abdominal condition. While a sudden attack of sharp pain, in the hospital cases, had invariably brought one of the members of the interne staff to the patient's bedside, the records show that a very careful search at that time for the slightest amount of muscular rigidity had not been carried out. This is perhaps too much to ask of them. The writer was once a member of this medical interne staff, and he now appreciates that at that time he was unquestionably unable in all cases to distinguish such differences. The importance of this subject was not sufficiently dwelt upon at that time in undergraduate instruction. The pathological conditions, however, which he then saw in the so-called "perforated" cases led him to the conclusion that it would be of the greatest value to the patient if the peritoneal changes, which had evidently been progressing in almost all cases for many hours before any acute symptoms had ap-

Digitized by Google

peared, could be detected very shortly after their onset. By broad analogy with the affections of the appendix it seemed probable that a beginning peritonitis in typhoid fever could often be arrested by early operation if the diagnosis could be made with a reasonable amount of certainty.

In considering the various signs of beginning peritonitis, none seemed constant except that of muscular rigidity. The ability, therefore, to detect its presence at its very beginning seemed most important for the surgical diagnostician. Since that time the constantly increasing number of patients brought to the hospital suffering from acute abdominal conditions associated with varying degrees of peritonitis has afforded to the writer such experience as he then desired, and in his bedside instruction to the students he has constantly endeavored to impress upon them the paramount necessity of familiarizing themselves at every opportunity with the various degrees of rigidity present in the different segments of the abdominal muscles in cases of peritonitis and of comparing these with the conditions found at operation.

Conclusions.

If the distinctly toxæmic cases are excluded, an "early operation" for the others should give excellent results. This "early operation" should be one undertaken very soon after the appearance of the lightest recognizable shade of abdominal muscular rigidity.

The writer believes that this "early operation" is not usually suggested because the diagnostic value of abdominal rigidity at its first appearance is not appreciated, and that on this account a persistent search for it is not made from the time that the patient begins to suffer from abdominal discomfort. The records show that it is only recognized as a rule when

Digitized by Google

marked pain is complained of, and unless other alarming symptoms are present that the case is unfortunately too often "watched" until the rigidity becomes general and a spreading peritonitis has become well established.

Enough evidence is at hand to justify the statement that an early exploratory operation exerts a distinctly beneficial influence, not only on the ulcers that may be about to break down but on others as well, thus preventing their further progress towards separate perforations, a condition recognized as almost invariably fatal (see Case V). Whatever may be the opinion held in regard to the advisability of peritoneal drainage for pus conditions originating in the female pelvis, or in cases of suppurative appendicitis, it seems that the co-existing typhoid poisoning should induce us here to follow that procedure which we believe will diminish peritoneal congestion, and by transforming the fluid variety of peritonitis about the ulcers into the adhesive one, bring about a protecting condition in their vicinity.

Digitized by Google

Digitized by Google

XXVI.

PNEUMOCOCCUS PERITONITIS.*

By George Woolsey, M. D., Associate Visiting Surgeon.

After the full development of the surgery of the appendix, it was the opinion generally felt and often expressed that acute peritonitis was always due to an inflammation of the appendix, or the pelvic viscera, or a perforative lesion of one of the abdominal viscera, or of the abdominal wall. As experience increased, however, cases of acute peritonitis occasionally occurred in the experience of many surgeons which could not be accounted for by any of these causes. Reports followed by several surgeons, of a small series of cases of acute peritonitis from "unknown sites of infection,"[1] or "without demonstrable lesion."[2] These and the cases related by other surgeons in the discussion of such reports were in many instances due to streptococcus infection, others to bacillus coli, and in other cases no bacteriological examination was made. The larger number of such cases, however, have been examples of pneumococcus peritonitis. Thus, in 1903, Jensen[3] collected and reported 106 cases (adults 48 and children 58), and many have been reported since. In 1906 Annand and Bowen[4] collected 91 cases below fifteen years of age. In fact, the greater number of the cases have occurred among children, and with few exceptions among girls. Thus, among 74 cases collected by v. Brunn[5] in 1903, 57

*Read before the Surgical Section of the New York Academy of Medicine, Nov., 1910.

(*Reprinted from the American Journal of the Medical Sciences, June,* 1911.)

Digitized by Google

were under fifteen years of age, and in 1906 Ashdowne[6] could only collect 31 cases among adults.

My interest in this subject was aroused by two cases of pneumococcic peritonitis which occurred in my service at the Presbyterian Hospital during the last year (1909), one in a girl, aged seven years, the other in a woman. I have made no attempt to collect all the cases reported since Jensen's paper in 1903, as the results would not justify the labor required.

The peritonitis may be a part of a pneumococcic septicemia, with multiple foci of infection, but more often it is (1) secondary to another local pneumococcic focus as a pneumonia, empyema, etc., "secondary cases," or (2) it is the first point attacked by the organism, "primary cases." Annand and Bowen[4] found the latter variety were more common among children in the proportion of 47 to 30, while v. Brunn[5] states that the secondary form is more common than the primary, but Annand and Bowen have placed 14 cases, whose classification was doubtful, in a third class.

The etiology of the peritonitis is a matter of the greatest interest. Among the secondary cases the primary focus is pulmonary (lungs or pleurae) in the great majority of cases (73 per cent.[3]). Next in frequency comes otitis media and throat infections. In cases secondary to pulmonary lesions does the infection reach the peritoneum through the blood or by penetrating the diaphragm? There is no evidence of the latter course. When the diaphragm has been examined microscopically, pneumococci have been found in one case in the pleural serosa and subserosa, and in a second case all through the diaphragm. But this case was one of pneumococcic septicemia with abscess of the shoulder-joint and endocarditis, and the organisms were certainly in the blood. Experimentally in animals to secure penetration of the diaphragm by the organ-

Digitized by Google

isms, it is necessary to use virulent cultures and to destroy the pleural endothelium by chemical irritants. Even then no peritonitis results. In the diaphragm, it is to be remembered the lymph current is away from the peritoneum. In cases secondary to otitis or a throat lesion, direct extension is out of the question. As it is established that in pneumonia in man pneumococci can be grown from the blood in nearly every case (Ewing), the presumption in favor of the peritoneum being infected through the blood in such cases is very strong, and is generally accepted by writers on the subject. Another explanation is also possible, and as it offers an explanation of the great preponderance of cases in children (and women too), the writer suggests it, though he has seen it nowhere mentioned. The sputum in cases of pneumonia is often swallowed in whole or in part, regularly by children, who seldom expectorate, and more often by women than by men. Pneumococci do not grow in acid media, and though they may normally be killed by the gastric juice, reduction of its acidity in disordered digestion may allow them to reach the alkaline small intestine. Of the 23 cases of diffuse pneumococcic peritonitis in adults collected by Ashdowne,[6] there were affections of the stomach in 5 (perforating ulcer in 3, chronic ulcer in 1, carcinoma in 1), indicating that the infection probably occurred from the stomach contents in these 5 cases. Numerous cases of enteritis in adults due to the pneumococcus are recorded, sometimes associated with peritonitis, and Jensen[2] mentions 2 cases in children. It has been found in a swollen Peyer's patch in a primary case.[4] Jensen,[2] experimentally, obtained general fibrinopurulent peritonitis and found pneumococci diffused through the gut wall in one of two young rabbits that were given 10 c.c. of a virulent culture of pneumococci. The appendix was affected in 3 of the cases collected by Ashdowne,[6] and a number of such cases

Digitized by Google

have occurred, especially in adults. It has been definitely established and accepted that the infection may and does occur from the gastro-intestinal tract in primary cases, and the condition of this tract appears not to have been investigated in secondary cases. The same explanation applies in cases where the primary focus is in the throat or middle ear, which drains into the throat, whence the discharges may be swallowed, but it does not apply in the two cases mentioned by Annand and Bowen, where an intermuscular abscess was the primary lesion.

But though this explanation might account for the relatively large number of cases occurring in children, it does not explain why such a large majority occurs among female children. In considering the etiology of primary cases, Jensen[8] gives the possible avenues of infection as follows: Through the abdominal wall (penetrating wounds, etc.); through the diaphragm (from the pleuræ); from the blood; through the intestinal canal; through the genital organs, and from other abdominal organs. In the primary cases one of the most likely channels is the alimentary canal. This has already been referred to above. Bryant[8] suggests that the diarrhea, so often present, may be an evidence of gastro-enteritis, which would determine the passage of living organisms through the stomach into the bowel and then through the wall of the latter. Quervain[9] reported a case of pneumococcic peritonitis in a child where five months later the appendix on removal was found to contain pneumococci. On the basis of this, and another case quoted from Krogius, Quervain thinks the appendix the commonest source of origin of the peritonitis in primary cases. Although such an etiology is somewhat more common in adults than in children, there is no evidence to prove that it is more than an exceptional one. Of the 91 cases collected by Annand and Bowen, 73 per cent. of all cases, 84 per cent. of the primary

Digitized by Google

cases, and 67 per cent. of the secondary cases were females. Both of the writer's cases were females, and all who have collected series of cases give a very similar result. These striking figures are very difficult to account for. They suggest as an important etiological factor the female genitals, especially as we know that they are the regular channel of infection in gonococcic and tuberculous peritonitis in the female. But there is very little pathological support to this theory. In one case recorded by Lop[6] the peritonitis followed delivery, and pneumococci were found in the lochia. Annand and Bowen[4] mention two cases where a congested tube was found, one where there was a slight vaginitis, another where there was slight vulvitis. It is possible that the pneumococci may pass through the tubes, causing but little local reaction, just as in a case of diffuse pneumococcic peritonitis the intestines may show comparatively little congestion, but, however strongly suggested by the figures given above, it must be admitted that there is singularly little pathological proof of the genitals being the common channels of infection. It is quite possible that in some cases the pneumococci have entered the circulation through an apparently intact mucosa and found in the peritoneum conditions favorable for development. In not a few cases the peritonitis and pneumonia occur so closely together that it is difficult or impossible to say which is the primary lesion. Jensen[2] found experimentally in animals that pneumococci injected into the peritoneal cavity were found in the blood in every case within a few minutes, four to five at the earliest. If the animals live long enough, the pneumococci diminish in the blood and eventually disappear if they recover. Thus, in a pneumococcic peritonitis, the lungs may become infected by the blood stream, and the reverse also occurs.

Digitized by Google

Clinically as well as pathologically two types are distinguished, the circumscribed and the diffuse forms. The difference is one of degree only; the circumscribed form sets in acutely, but passes into a subacute or chronic stage as soon as the pus becomes encapsulated. This tendency to the encapsulation and limitation of the process depends upon a characteristic feature, the formation of a fibrinoplastic exudate, which forms a false membrane and tends to localize the process. In the diffuse form there is less fibrinoplastic exudate; the pus is not encapsulated, the acute symptoms persist, and it does not differ essentially from other varieties of diffuse peritonitis. Either of these types may be of the primary or secondary variety; hence we may distinguish four varieties. My experience is limited to the diffuse form.

The characteristics of primary diffuse pneumococcic peritonitis are the acuteness of the onset and the severity of the symptoms, intense pain, vomiting, diarrhea, and prostration, passing on to the terminal symptoms of peritonitis if unrelieved by operation. The temperature, pulse, and leukocyte count are all high; there is general abdominal tenderness and rigidity, which may be more marked below the umbilicus or even in the right lower quadrant. There may be tympanites, with dullness in the flanks; in fact, the signs are those of a diffuse septic peritonitis.

In the secondary diffuse form the onset of the peritonitis and its signs and symptoms are marked enough in about half the cases (47 per cent.[4]) to point definitely to its presence. In the other cases the primary condition or the presence of a severe general infection (in nearly half the cases), as indicated by multiple lesions (pericarditis, etc.), so obscure the local manifestations as to prevent their clinical recognition. When the peritonitis has been diagnosticated in these cases

Digitized by Google

its symptoms and signs have been for the most part the same as in the primary form.

In the primary circumscribed form the onset is acute with abdominal pain, possibly localized at first, but soon becoming general, vomiting, at first or for some days, and diarrhea, which is more persistent. The fever and other constitutional symptoms, as well as the local ones, characterizing the first stage, subside in ten to fourteen days. In this form the inflammation becomes encapsulated by adhesions and the fibrinous character of the exudate, so that in the second stage we have the formation of an intraperitoneal localized abscess. This is usually subumbilical, and rather more to one side than mesially. During this stage there may be constipation, the patient emaciates, the lower abdomen swells, and there is slight rise of temperature. At times the general condition remains good. If unrelieved, the abscess tends to perforate a month or so after the onset, and usually at the umbilicus. By this time the cachectic and emaciated appearance and the distended abdomen suggest tuberculous peritonitis.

In the secondary circumscribed form, as in the secondary diffuse form, the primary infection may mask the onset of the peritonitis if the latter sets in immediately after the onset of the primary infection, or if the latter is merely the first local manifestation of a pneumococcic septicemia. Otherwise and in its second and third stages the secondary is the same as the primary circumscribed form. In the 91 cases collected by Annand and Bowen,[4] 21 were of the primary and 19 of the secondary diffuse forms; 26 were of the primary and 11 of the secondary circumscribed forms; while 14 cases were unclassified.

DIAGNOSIS. From the above brief summary of the clinical manifestations of pneumococcic peritonitis it will be observed

Digitized by Google

that there is little that is distinctive about the disease to distinguish it at the outset from an appendicular or perforative peritonitis. The pain is often referred to the right lower quadrant more than to other regions of the abdomen, and in appendicitis in children, in whom pneumococcic peritonitis is most prevalent, the pain is often not well localized, particularly in the early stages. Diarrhea is a very constant accompaniment of pneumococcic peritonitis, whereas constipation is the rule in appendicitis. But here again we find that diarrhea is not at all uncommon in appendicitis in children, in whom pneumococcic peritonitis is relatively most often found. Diarrhea is also a not uncommon accompaniment of peritonitis due to a pyosalpinx or a pelvic inflammation. The fact that pneumococcic peritonitis occurs most often in children and in females and that it is regularly accompanied by diarrhea, are the only distinctive features to assist in the diagnosis. If my first case is not an exceptional one, the leukocyte count may be of assistance in the diagnosis, for in this case it was very high, 67,000 (polymorphonuclears, 94 per cent.). In the second case, however, it was only 19,000. The high count in the first case may have been due to the pulmonary condition which soon manifested itself. In spite of all slightly distinctive features, the acute diffuse form is almost always operated on for appendicitis or a perforative peritonitis. Michaut[10] stated, in 1901, that whereas the diagnosis has frequently been made in the encysted form, it has only once been made in the diffuse form.

The secondary diffuse form is no easier of diagnosis, for in more than half the cases its onset is obscured by the symptoms of the primary infection or by other secondary lesions. The history of the case and the fact that peritonitis is one of the commonest, if not the commonest secondary lesion in pneumococcic infections, especially in female children, is often the only

Digitized by Google

clue we have. Hence the importance of the history in the secondary cases.

In the circumscribed form, unless the history of the acute onset, or, in some cases, of the previous pneumococcic infection is obtained, the diagnosis is not likely to be made until the appearance of the localized abscess. Sometimes it has not been made until the latter bursts, or is on the point of bursting.

As in the secondary diffuse form, so in the secondary circumscribed form, the diagnosis may be obscured by the primary lesion so that no diagnosis is made until an encapsulated abscess forms.

At the time of operation the gross pathological character of the pus is sufficiently marked to suggest the diagnosis, for the pus is odorless, yellowish, or greenish yellow, and is distinguished by fibrinous flakes or masses in the pus, and on the bowel. In some cases a secondary infection with bacillus coli communis may give the pus an odor, and the amount of the fibrinous exudate varies, being less abundant in the diffuse cases.

While, on the one hand, it is necessary to diagnosticate cases of pneumococcic peritonitis which are secondary to pneumonia, etc., on the other hand there are cases of "delayed pneumonia," in which all the symptoms point at first to peritonitis, such as that due to appendicitis, although there may be no actual peritonitis present. Such a case should be carefully considered to avoid an unnecessary operation. An example of this class of cases also occurred in my service during the previous year, and was as follows:

Miss W. F., aged twenty-four years, single, was admitted to the Presbyterian Hospital February 18, 1909. For five months she had felt badly, with persistent drowsiness, constant headache, and loss of appetite, though she feels hungry. She is apt

Digitized by Google

to vomit after breakfast, and has palpitation and shortness of breath. No loss of weight. Leucorrhea for last three months, for which she had used a vaginal douche with a dirty tip. Five days ago she contracted a severe cold. She coughed a great deal, and raised much thick, yellowish sputum, and vomited after severe coughing spells. For last three days she was more acutely ill, with high fever, chilly sensations, severe headache, vomiting of everything eaten, and languor. Some general abdominal pains. Bowels had not moved for three days.

Examination.—A few inconstant rales in both apices, harsh breathing in right apex. Abdomen tender all over, especially in right lower quadrant, with well-marked tenderness at McBurney's point. Slight rigidity; no masses felt. Rectal examination shows right-sided tenderness. Neck somewhat rigid. Muscles of calves and thighs extremely tender. Urine negative. After admission the temperature ranged between 104° and 106° for the next three days. The leukocyte count rose from 12,500 (polymorphonuclears, 97.5 per cent.) on February 19, to 21,700 on February 20, and 23,700 (polymorphonuclears, 95 per cent.) on February 22. On February 20 Widal reaction was negative, blood culture was sterile, and there were no malarial plasmodia. On February 22 smears from urinary sediment show staphylococcus, and a culture from catheterized specimen gave a pure growth of bacillus coli. The urine now contained albumin (3.1 per cent.), a trace of indican, pus, and red blood cells. A hematogenous renal infection was thought of in connection with slight pain and tenderness over the right kidney and the urine analysis. The patient was seen by the house physician, and then by the attending physician, who declared that there was nothing in the lungs. The cough bothered her considerably. The bowels were loose, moving eight to nine times a day; the movements were greenish. The patient

Digitized by Google

was very prostrated and irrational at times. I was confident that there was no appendicitis, though the pain and tenderness in the right lower quadrant continued to be the only local signs. On February 22 a tender mass was felt in and to the right of the median line, in the hypogastrium. In order to determine if possible, the cause of the symptoms, an exploratory laparotomy was made. The mass felt was found to be the distended bladder, though she had been catheterized a few hours before. The appendix, peritoneum, and all abdominal organs were found negative. After operation the temperature fell somewhat (to 102°), but the following day the pulse rate rose to 140; she began to be dyspneic and cyanosed, and beginning consolidation was found in the right upper lobe. She was transferred to the roof and to the Medical Service, but failed to respond to stimulation, and died February 24, at 7.30 P. M. There was no autopsy allowed, but all the signs of a frank pneumonia were present. I have also seen cases of acute appendicitis in young adults in whom the early symptoms were referred to the right thoracic region. This is not uncommon in children, in whom the reverse is still more common, that is, pain referred to the abdomen in cases of pneumonia.

PROGNOSIS. Whether the peritonitis is primary or secondary does not appear to affect the prognosis, according to Annand and Bowen,[4] but the latter does depend upon whether it is diffuse or encapsulated, whether or not it is operated upon in due time, and whether or not there are other severe complications. Of 46 cases of diffuse peritonitis in their table, 18 were operated upon, with a mortality of 66.6 per cent., while all those not operated upon died. The total mortality of the diffuse form was, therefore, 86 per cent. Of 45 cases of circumscribed appendicitis, 44 were operated upon, with a mortality

Digitized by Google

of 13.9 per cent. An early and correct diagnosis followed by a prompt operation will favorably affect the prognosis.

TREATMENT. The treatment is surgical. Early operation affords the best prognosis. The operative treatment is the same as that of other varieties of diffuse or circumscribed peritonitis, except that there is usually no portal of infection that requires removal or local treatment. In most cases the operation will be undertaken without an accurate diagnosis. If the pus is odorless, flocculent, greenish or yellowish green, and without free gas, the viscera need not be searched for a perforation. The appendix will probably have been examined, and it is very desirable to examine the pelvic viscera to determine the etiology. In the acute diffuse form, Annand and Bowen think that mopping out the pus and closing the incision without drainage appears the wisest course. It is probably better for each operator to follow the technique he is accustomed to in acute diffuse peritonitis from other causes. Personally, I generally employ drainage. In the encapsulated form the operation merely consists of opening and draining a localized intraperitoneal abscess. The following is the history of the case of acute pneumococcic peritonitis upon which I operated:

M. C., a girl, aged seven years, was admitted to the Presbyterian Hospital January 30, 1909. One week before, she began to have sore throat, cough, abdominal pain, fever, anorexia, and diarrhea.

January 28 she had sudden abdominal pain and tenderness in the entire lower abdomen, and vomited almost all day. The following day there was no vomiting, but the pain and tenderness continued.

On admission the abdomen was somewhat distended, symmetrically, and showed much restriction of the respiratory movements. The abdomen was everywhere rigid and tender, especially in the right lower quadrant. Percussion was tympanitic everywhere, except about McBurney's point, under which there was the sense of a mass, and in both flanks, where there was shifting dulness. Lungs: breath sounds exaggerated over both upper lobes in front; there was dulness over the right base posteriorly and over the outer part of the right scapula. The breath sounds were diminished over the base.

Digitized by Google

Temperature, 104°; pulse, 100; respiration 56; leukocyte count, 67,000 (polynuclears, 94 per cent.); blood pressure, 85.

On the diagnosis of a diffuse peritonitis probably due to appendicitis, she was operated on at once, January 30, by the usual muscle-splitting incision over the appendix. The latter was retrocolic and normal, but was removed. The peritoneal cavity was filled with an odorless yellowish seropus, with fibrinous flakes, thicker and more yellow in the pelvis. No perforation in the ileum, and the mesenteric nodes were not enlarged. Through a median epigastric incision the stomach, duodenum, and gall-bladder were examined and found normal. There was only a little pus above the transverse colon. No cause of peritonitis found. Drain to pelvis. Upper wound closed. Infusion of 500 c.c. normal saline solution given on table. Patient in Fowler's position and enteroclysis given, but not well retained.

Culture of pus showed pure culture of pneumococcus. February 2, signs of consolidation at right base; also bronchial breathing at left base. Croup kettle employed. Slight distention relieved by enemata. Irrational much of time. February 6, temperature, respiration, and pulse lower and dyspnea less. Fowler's position stopped on third and enteroclysis on fourth day. Still has frequent loose dejections, with mucus. She is more rational. Coughs a great deal, and as a result the median abdominal wound has begun to open up. Only a slight shreddy purulent discharge from the lower wound. February 8, temperature has been down to 99.4°, but is up again to 103.5°. Consolidation on both sides to near angle of scapulæ. Pulse and general condition slightly improved. Ten c.c. of Hiss' serum was given on February 9, and the following morning she was moved to the roof and the croup kettle stopped. Twenty c.c. of Hiss' serum was given during February 11. The lower wound discharges moderately. Temperature fell gradually to 99.8° on March 1, then rose to 102° on March 3, when a mass in right lower quadrant, at lower angle of wound, was opened through the wound and several ounces of foul pus evacuated. March 13, upper wound practically closed. On March 17 the patient commenced to vomit, and continued to for three days. Bowels constipated, but moved to enemata. Some cramp-like pains were present and a mass was felt in left lower quadrant. Obstruction feared, but symptoms decreased and patient felt well again, though a definite but smaller mass was still palpable April 1. On her discharge, April 10, there was a well-marked hernia in upper wound. Except for the latter, she was in fine condition when presented to the New York Surgical Society on April 28, 1909.

In April, 1909, another case was brought into the hospital in a moribund condition. Mrs. K. had had for five years a tender spot just above and to right of umbilicus. No other symptoms suggestive of gastric ulcer. Five days ago at 2 P. M., she was suddenly seized with a terrible cutting pain about the umbilicus, lasting five minutes, followed by general but less severe abdominal pain. She had a chill with the onset, vomited soon after, and has been prostrated since. The vomiting has persisted almost continuously. She was dis-

Digitized by Google

tended, and belched much gas. Daily enemata, with scant results. Bowels involuntary to-day. Temperature 105° three days ago.

On admission she was in collapse, with a cold, clammy, mottled surface and almost pulseless. Lungs negative anteriorly. The abdomen was moderately distended, tympanitic, except in flanks, where there was shifting dulness, especially on right side; tender all over, especially in lower half, but not rigid. Peritonitic fascies. Pelvis: laceration of cervix and perineum; menstruating; leukocyte count, 18,000 (polynuclears, 87 per cent.); temperature, 100.4°; pulse, 160; respirations, 36. As she did not respond to stimulation, operation was out of the question, and she died within a few hours. On autopsy, abdominal organs were normal and presented no perforation. Lungs normal. There was a diffuse peritonitis, with a greenish-yellow, flaky, purulent exudate. Culture gave a pure growth of pneumococcus.

REFERENCES.

[1] Dowd: Annals of Surgery, 1908, XLVIII, 821.
[2] Martin, E.: Annals of Surgery, 1906, XLIV, 917.
[3] Jensen: Archiv. f. klin. Chir., Band LXIX, Heft 4; Band LXX, Heft 1.
[4] Annand and Bowen: Lancet, June 9, 1906, p. 1591.
[5] v. Brunn: Beiträge z. klin. Chir, 1903, Band XXXIX, Heft 1.
[6] Ashdowne, W. C. G.: Lancet, January 20, 1906, p. 155.
[7] Burckhardt: Beiträge f. klin. Chir., 1901, Band XXX.
[8] Bryant: Brit. Med. Jour., 1901, vol. II.
[9] Quervain: Centralblatt f. Schweizer Aerzte, 1902.
[10] Michaut: Gazette des Hôpitaux, 1901.

Digitized by Google

XXVII.

LEUKEMIC TUMORS OF THE BREAST MISTAKEN FOR LYMPHOSARCOMA.*

By CLARENCE A. MCWILLIAMS, M. D., ASSISTANT VISITING SURGEON,

AND

FREDERICK M. HANES, M. D., ASSOCIATE VISITING PATHOLOGIST.

The case herewith reported is so remarkable that it deserves record. So far as we know it is unique, and from it one may learn several lessons. The history is as follows: A married woman, aged thirty-three years, was admitted to the hospital, June 13, 1911. She said that two weeks previously she had noticed a lump in the right breast which was not tender nor painful. It had not grown any since she noticed it. There was no loss of weight. She had one child, now aged eight years. She never had had any inflammation of the affected breast. Examination showed in the right mammary gland at its upper and outer quadrant a small nodule, the size of a hickory nut, not tender, nor cystic, firm to the feel, and not attached to the skin. No axillary nodes were palpable. The remainder of the breast contained no nodules nor were there any in the opposite breast.

On June 14, 1911, the tumor was excised. A frozen section at the operating table was not satisfactory so the wound was closed. A subsequent pathological examination showed the tumor to be benign, the diagnosis being a lymphoma. The pa-

*(*Reprinted from the American Journal of Medical Sciences, April,* 1912.)

Digitized by Google

tient went home. She returned to the hospital five months later saying that after she had been home a month another small lump developed near the old scar in the right breast and this was followed by the appearance of two or three other lumps in the same breast. Two weeks prior to her second admission into the hospital, she noticed a lump in the left breast. All the tumors had been growing steadily larger since she first noticed them. She had had no pain in them and they were not tender. There was no discharge from the nipple nor was there any loss of flesh or strength.

In the right breast beneath the nipple were three hard, nodular masses, movable, circumscribed, not attached to the skin which was movable over the tumors. In the right axilla there was felt a mass the size of a hickory nut. In the left breast in its upper quadrant were two distinct masses, freely movable and hard. Nothing was felt in the left axilla. All the other organs were normal. The spleen was not felt. There were no other tumors anywhere, no enlargements of any of the lymphatics, except in the right axilla. The Wassermann reaction was negative. The patient was seen by Dr. Joseph A. Blake, who expressed the opinion that radical operations should be done on the breasts, since the tumors were probably malignant (sarcoma), although the outlook for a permanent cure was very gloomy. It was unfortunate that no blood examination was made at this time. Had a differential count been taken the true condition, leukemia, would have been evident and the patient spared unnecessary operations. She was examined by a number of men not one of whom suggested the advisability of a blood examination. To avoid such mistakes we would suggest in all institutions where it is possible, that a routine differential blood count be taken in all surgical cases.

Digitized by Google

On November 7, 1911, the radical removal of the right breast with both pectorals and the contents of the axilla was performed by one of us (McWilliams). Numerous enlarged glands were removed, one being from the very apex of the axilla. Perfect and undisturbed primary union followed this operation.

Pathological Examination.—The nipple was not retracted but appeared normal. Throughout the breast substance, particularly just above and outside the nipple, were several rounded masses, varying in size from a pea to a hen's egg. Between these larger masses could be seen, on closer inspection, small circumscribed lobules 3 to 4 mm. in diameter, in places closely packed together, in others arranged as strands and then sheets. These smaller masses corresponded in some instances to normal breast parenchyma, in others they were fringed about the large nodules. They differed from the ordinary glandular appearance of normal breast parenchyma in that they stood out from the stroma and showed their lobulated character very distinctly. The substance of the larger and smaller nodules appeared the same. They were of a rather dull or grayish-pink color, firm and fleshy though not hard, quite even and homogeneous, showing no areas of necrosis nor hemorrhage nor trabeculæ of any sort. The edges of the nodules were circumscribed, but showed no capsule and were seen to be attached to the surrounding subcutaneous tissues as an evenly outlined infiltration. The skin was nowhere attached to these nodules, but some of them were intimately connected with the fascia covering the muscle. There were many soft lymphatic nodes in the axilla varying from 0.5 cm. in diameter to 2.5 cm. They appeared evenly covered, dull pink, and homogeneous in substance. The muscles showed nothing abnormal.

Microscopic Examination.—The nodules showed an enormous number of small cells with scarcely visible cytoplasm con-

Digitized by Google

sisting chiefly of a nucleus, that is, round or ovoid, clear-staining, but containing particles of chromatin that often stained very deeply. These cells were supported by a delicate stroma clearly seen by Mallory's stain. There were few blood vessels in the area, but where the cells were near vessels, the vessel wall was not disturbed. In less dense areas where in the gross small lobules could be made out, these cells were found to closely surround the acini and terminal ducts of the breast lobules and were chiefly confined to the intralobular stroma. No extensions into the muscle substance were found. At one point in the axillary tissues a vein was found containing a number of small, round cells which might have been lymphocytes or tumor cells from their appearance. The normal anatomy of the larger lymph nodes was somewhat lost. They showed no germinal centres and were made up of small, round, mononuclear cells resembling lymphoid cells. They showed chronic hyperplastic lymphadenitis. The diagnosis of lymphosarcoma was made.

With this apparently clear cut diagnosis, operation was performed on the left breast on November 15, 1911. The radical operation for removal of the breast with both pectorals and the axillary contents was performed. Considerable shock followed this second operation, and that evening the patient's condition was poor with a weak, irregular pulse, and considerable dyspnea. There was very little response to two saline intravenous infusions, so blood transfusion was performed at 9 P. M., her husband being used as donor without preliminary testing of the hemolytic action of the two bloods. Immediately before the transfusion the patient's red cells were 3,000,000, and immediately after it they numbered 4,000,000. Elsberg's cannula was used with good result. The next day the patient's condition was perfectly good, her pulse being strong and steady.

Digitized by Google

There was likewise perfect and undisturbed primary union of the wound on this side. Pathological examination of the left breast showed conditions precisely similar to those of the right breast with the exception that the nodules were considerably smaller and more isolated, while the lobular appearance of the breast tissue showed more distinctly.

One week later, at the suggestion of the pathologist, a differential blood count was made, whereupon the diagnosis was cleared up. It showed 117,000 white cells of which 90 per cent. were lymphocytes. The successive blood counts were as follows: November 22, leukocytes, 117,000; polymorphonuclears, 8.4 per cent.; lymphocytes, 90 per cent. November 27, leukocytes, 180,000; polymorphonuclears, 2.6 per cent.; lymphocytes, 96 per cent.; red blood cells, 3,000,000; hemoglobin, 65 per cent. December 2, leukocytes, 280,000; polymorphonuclears, 2.25 per cent.; lymphocytes, 96 per cent.; hemoglobin, 30 per cent. December 4, leukocytes, 250,000; polymorphonuclears, 1 per cent.; lymphocytes, 96.5 per cent.; red blood cells, 1,600,000; hemoglobin, 25 per cent.

On November 23 the patient began to have a temperature which became continuously higher each day until her death on December 14. On December 3 the examination of the eye grounds showed that in the left retina there were two hemorrhagic spots on the temporal half near the region of the macula. The right eye was normal. She was then transferred to the medical division, service of Dr. Janeway. On December 5, the edge of the spleen was felt for the first time on deep inspiration three-quarters of an inch below the costal margin and the gums of the lower jaw were swollen, spongy, tender and showed some small ulcerations, and the left tonsil was ulcerated. On December 7, she began to have persistent diarrhea, which continued until her death.

Digitized by Google

The report of the autopsy, performed by one of us (Hanes) at 7 P. M., on December 14, 1911, is as follows:

The subject is a small, emaciated female, measuring 160 cm. Rigor mortis not present. Both breasts have been removed by surgical operation, leaving normal scars. In the posterior triangle of the neck on both sides small, bean-sized glands are felt; the glands elsewhere are not enlarged. The mucous membranes are extremely pale. On incision the panniculus adiposus over the abdomen measures about 1 cm. The abdominal cavity is free from fluid and the peritoneum is everywhere glistening. The appendix is normal. All of the abdominal organs are free from adhesions excepting the spleen, which is adherent to the lateral peritoneum over its lower third by old dense adhesions. Both lungs collapse upon opening the thorax and there is no fluid in either pleural cavity. The right lung is free from adhesions but over the posterior surface of the left lower lobe there are old adhesions. The pericardium contains about 50 c.c. of blood-stained fluid.

Heart.—The heart is of normal size. Along the course of the anterior coronary artery there are hemorrhages under the pericardium, and along the lower half of the left coronary similar hemorrhages are seen. The valves are normal and competent throughout the heart. The heart muscle shows no abnormality.

Lungs.—Left: There are tags of old adhesions along the posterior surface of the left lower lobe, and for a space the size of a dollar on the diaphragmatic surface of the left lower lobe there are several small, yellow accumulations which can be torn from the underlying pleura and seem to be fibrinopurulent in character. The lung parenchyma seems normal on section. Right: The right lung is normal.

Digitized by Google

Trachea and Bronchi.—The mucous membrane of the trachea and bronchi is very pale, otherwise normal.

Spleen.—The spleen is enlarged, weighs 135 grams, measures 12x6.5x3.5 cm. It is adherent along its lower pole to the peritoneum, but can be separated from it without tearing the capsule. The spleen is moderately firm in consistence, the edge is rounded. On section the spleen maintains its shape. The splenic pulp is of a greyish red color, moderately firm, it scrapes off readily with the knife. The trabeculæ are easily seen. Malpighian bodies are very indistinctly seen. There are small hemorrhages scattered through the substance of the spleen.

Liver.—The liver weighs 1,510 grams, measures 27x22x6 cm. The surface is smooth. The color is yellowish-red and finely mottled over its entire surface. These fine mottlings are from the size of a small pin-head to a match-head, and they do not project beyond the surface. On section the liver has about the appearance as seen through the capsule. The lobulations are not distinct. There are many small, whitish-yellow nodules scattered through the liver which range in size from a pin-head to a match-head, occasionally they are as large as a pea.

Gall-bladder.—The gall-bladder and bile ducts are normal.

Esophagus.—The esophagus is normal.

Stomach.—The stomach shows no abnormality besides pallor of mucous membrane.

Intestines.—The entire length of the small and large intestines is the seat of inflammatory changes in the mucosa which become more intense as one proceeds from the stomach. In the duodenum the mucous membrane is injected and red, and as one proceeds into the ileum this condition becomes more marked, and the mucous membrane is greatly thickened. Peyer's patches throughout the ileum are enlarged and in places

Digitized by Google

slightly ulcerated. The lower ileum shows quite marked congestion and edema of its mucous membrane, and the crest of the folds are covered by a brownish, necrotic substance. The blood vessels of the surface are markedly injected. As one passes the ileocecal valve, the congestion and edema of the mucosa is much more marked, and the crest of the folds of the mucous membrane shows a brownish, necrotic substance partially replacing the mucous membrane. The same condition extends to the rectum where it is rather less marked than elsewhere in the large intestines.

Lymph Glands—The glands throughout the mesentery are enlarged from the size of a pea to a lima bean. Some are red and congested on section, while others show a pale yellow, succulent, homogeneous surface. The glands nowhere show necrosis. The retroperitoneal lymph glands from the diaphragm to the coccyx are enlarged. They form two parallel chains, each about 2 cm. in thickness. These chains are composed of glands which, on section, present a mottled yellow-red surface in which no normal lymph gland structure can be seen.

The mediastinal lymph glands are not markedly enlarged. The bronchial glands, however, show moderate enlargement. At the bifurcation of the trachea there is a gland measuring 3x1.5 cm. On section part of the gland is anthracotic, but one gets the impression that this part represents the old gland while the remainder of the gland, which is pale-yellow in color, represents the hyperplastic glandular tissue.

Pancreas.—The pancreas is extremely pale, its consistence is decidedly firm. On section the pancreas cuts with an elastic feel. The pancreatic duct is patent.

Tonsils.—The tonsils are enlarged to the size of a hickory nut, and both, especially the left, show marked ulceration, its

Digitized by Google

surface being covered with a brownish, necrotic mass. This necrosis has extended to the surface of the left anterior pillar of the fauces.

Larynx.—The larynx is normal.

Thyroid.—The thyroid is normal.

There are a few small glands along the course of the internal jugular vein which nowhere exceed the size of a small bean.

Genito-urinary Tract.—Both kidneys are alike. They are of normal size. The capsule strips easily leaving a very pale surface. The stellate veins stand out prominently. On section the cortex stands out sharply from the medulla because of its pallor, which is marked. The cortex measures 6 mm., the striations are faintly seen. There are no nodular accumulations seen. Both ureters are moderately dilated but free from constrictions. The bladder is normal. The uterus and appendages are quite normal in appearance.

Bone Marrow from Femur.—The marrow is not increased in amount, is soft and of a dark red color.

MICROSCOPIC NOTES. *Bone Marrow.*—The normal structure of the bone marrow is well preserved, but its substance is occupied almost completely by one type of cell. The cell is a mononuclear with very scanty cytoplasm. The nucleus is vesicular, rather clear and measures on the average from 6 to 8 micra in diameter. An occasional megakaryocyte is seen and there are scattered through the bone marrow small islands of erythroblasts. There are a few cells with plentiful cytoplasm and large, round, vesicular nuclei which looks like myelocytes.

Lymph Glands.—Throughout the body they present the same histological appearance, which will be illustrated by a description of a retroperitoneal lymph gland. The gross structure of the lymph gland is recognizable and the capsule is intact. Here, just as in the bone marrow, one type of cell largely

Digitized by Google

predominates, namely, a mononuclear cell measuring on the average from 6 to 8 micra, the nucleus being vesicular and clear and the cytoplasm scanty. Small mononuclear cells with pyknotic nuclei are occasionally seen and there is an occasional normoblast.

Thymus contains a great deal of dense fibrous tissue, within the meshes of which are masses of mononuclear cells similar to those described in the lymph glands and bone marrow. No remains of thymic tissue are seen.

Spleen.—The Malpighian bodies are present. They are composed of vesicular mononuclear cells similar to those described elsewhere. The splenic pulp contains a diminished quantity of red blood cells, its substance being largely composed of vesicular mononuclear cells, with here and there typical mononuclear leukocytes. There are, in addition, large mononuclear cells with rather plentiful protoplasm, the nucleus being vesicular.

Liver.—In the peripheral connective tissue there are occasional accumulations of vesicular mononuclear cells with an occasional normoblast and a few lymphocytes. There is a moderate grade of fatty infiltration of the parenchyma.

Kidney.—In the kidney there is a patch of leukocytic infiltration, the cells here being of the same type as those described in the lymph glands and bone marrow.

Intestines.—Both the small and large intestines show diphtheritic enteritis. The mucous membrane is desquamated over considerable areas. The blood vessels of the submucosa are greatly dilated and there is a profuse inflammatory exudate which is composed almost entirely of lymphocytes, the prevailing lymphocyte being here a mononuclear similar to those described in the lymph glands and elsewhere. There are, in addition, many plasma cells.

Digitized by Google

A section of one of the breast nodules noted upon the second admission shows the following picture: There are alveolar structures lined by cuboidal epithelium with a distinct basement membrane, which are surrounded and embedded in a mass of mononuclear leukocytes. These leukocytes measure on the average from 6 to 8 micra, and the nucleus is round, clear, and vesicular. They are obviously the same type of lymphocyte as those previously described in the other organs.

To summarize, then, the case is surely one of lymphatic leukemia, with, however, very unusual features. The patient complained first of a tumor of the breast, and probably referred any slight evidences of impaired health to this tumor, whereas the subsequent course of the disease and the autopsy show that the breast tumor was merely an incident in the leukemic process. The superficial lymph nodes were never enlarged. The spleen was not palpable until late in the course of the disease. A study of the various blood-forming tissues reveals a transformation from the normal to a tissue in which one type of mononuclear cell greatly predominates.

The patient developed toward the close a severe enteritis, and it is interesting that the type of cell which took part in the inflammatory exudate was the mononuclear cell seen elsewhere so abundantly, and not the polymorphonuclear leukocyte, a finding easily explained by the condition of the bone marrow, in which very few myelocytes were found.

Digitized by Google

Digitized by Google

XXVIII.

A CONTRIBUTION TO THE SURGICAL TREATMENT OF SPINAL CORD TUMORS.*

By George Woolsey, M. D., Associate Visiting Surgeon.

The technic of operations for the removal of intraspinal tumors first involves a laminectomy. At the outset we must determine whether we will do a simple or an osteoplastic laminectomy. My personal preference is strongly in favor of a simple laminectomy, for as a rule the simplest technic is the best. It gives the best and most free exposure and can more readily be extended in either direction to meet the conditions in a given case. It is the easiest, takes less time and is the safest. It does not essentially weaken the strength or the carrying or supporting power of the spine to remove three to five laminæ, for the latter do not bear any weight except possibly to a slight extent in the upper cervical region. This is also borne out by experience. The cord is amply protected by the thick covering of muscles and fascia over the firm theca. Furthermore as, before the removal of the laminæ, an attempt is often made to spare the superficial periosteum, more or less of a bony covering may be reproduced. This was not found to be present, however, in Case III, reoperated one year after the first operation. The spine is somewhat stiff at the laminectomy site but no more stiff, if as much so, as where an Urban or Hartley-Bickham operation is done.

"Examination" of cases and "Remarks" are by Dr. J. Ramsay Hunt.

(*Reprinted with some omissions from Annals of Surgery, September, 1910.)

Digitized by Google

If any form of osteoplastic operation is done the only one I would consider would be that known as Cavicchia's as practiced by Durante. Abbe has employed a very similar procedure in the intraspinal division of the posterior nerve roots for neuralgia and also in operations on intraspinal tumors. It consists of laying back a muscular flap including the spinous processes. Through a slightly curved or angular incision a little to one side of the median line the superficial muscles are split longitudinally a little to one side of the spines, the longissimus dorsi group of this side is divided transversely at the upper and lower ends of the slit and retracted toward the median line to allow the division of the spines at their bases. The muscles of the opposite vertebral groove are then elevated from the laminæ and retracted, with the severed spines and longissimus dorsi to allow the removal of the laminæ. There is little if any less hemorrhage than in simple laminectomy, in which the hemorrhage is readily controlled. The only bony portions left are the spines, and these can add little if any to the strength of the column. Besides, in the dorsal position the rough bases of the spines are pressed toward the dura and might possibly cause irritation of it. The method therefore seems to me inadvisible and should be discarded in favor of the simple laminectomy. The unilateral laminectomy employed by Taylor in the intraspinal division of posterior nerve roots does not give sufficiently free access for the removal of tumors. Sonnenburg attributed a fatal result from meningitis, due to infection, to the use of Urban's osteoplastic method.

A modified Sims' position on the left side with the patient as prone as possible, is suitable for any part of the spine. The patient should be on the left side, as this is more convenient for the operator, whether the tumor is on the right or left side. Or the patient may lie prone on the belly. The part

Digitized by Google

to be operated on should be flexed as much as possible, to facilitate the laminectomy by separating the laminæ as much as possible and by making the spines prominent posteriorly; and it should be higher than the head and the rest of the spine as well, to limit the escape of cerebrospinal fluid when the dura is opened. This position can be quickly obtained in part by lowering the head somewhat in the Trendelenburg position, or, better, by the use of the Lilienthal bridge on the operating table. The use of cushions under the part of the spine to be operated on answers all purposes in most cases. When the operation is upon the cervical region the prone position, with the head supported on an extension head rest and the shoulders raised so as to allow thoracic and abdominal respiration, is a convenient one.

In view of the fact brought out by Crowe,[14] that urotropin is excreted by the cerebrospinal fluid, fifteen grains of this drug should be administered shortly before the operation, as its maximum concentration in the fluid occurs from one-half to one hour after its ingestion. It should also be continued after the operation in divided doses for several days, giving thirty grains or more every twenty-four hours, on account of its inhibitory effect on the growth of organisms in the cerebrospinal fluid, thus minimizing the danger of meningitis.

In order to determine the position of the incision the spine or spines should be found under whose neural arch the neurologist has localized the tumor. Except in the cervical region it is better to count the spines from above and below, above from the vertebra prominens, below from the fourth lumbar spine, on a level with the highest point of the iliac crests. In patients not too stout we can follow up the twelfth rib to the upper end of the twelfth thoracic vertebra as an additional landmark. It is also convenient to remember that

Digitized by Google

the vertebral end of the spine of the scapula corresponds to the third thoracic spine, for in some cases, where the sixth cervical spine is more, or the seventh less, than usually prominent, it is hard to make sure of the vertebra prominens and to distinguish it from the sixth cervical or the first dorsal spines. When in such cases it is difficult to count the spines accurately, all such accessory landmarks are useful. In operations on the cervical region, after the spinous processes are exposed, it is well to remember that the spine of the sixth cervical vertebra is the lowermost bifid spine of the cervical vertebræ.

If a bed-sore exists on the back it should be thoroughly treated by 95 per cent. carbolic acid, followed by alcohol and then painted thickly with iodine. The area should then be excluded from the field of operation by a light dressing covered with thick gutta-percha tissue fastened to the skin around it by chloroform.

The median incision, having its centre opposite the diagnosed position of the tumor, is carried down directly to the tips of the spines and should be ample, at least 10 cm. and often 15 cm., corresponding to a minimum of three or four spines and often to five or more. A transverse incision through the aponeurosis at either end of the incision may be made to allow of easier retraction of the edges and exposure of the spine, but is not necessary. After dissecting around to either side of the three or more spines exposed, the soft parts are rapidly removed from either side of them by blunt dissection, aided by the knife, down to their junction with the laminæ. It is not necessary to do this superiosteally. To give more room for the next step, the clearing of the soft parts from the laminæ, the spines may now be cut off at their bases by a bone forceps bent on the flat, after dividing the supra-

Digitized by Google

spinous and interspinous ligaments between them, or this step may be deferred until the laminæ are cleared. The latter is accomplished by a periosteal elevator or raspatory, by which it is sought at the same time to strip back the periosteum. In freeing the soft parts from the spines and laminæ, there may be considerable hemorrhage, mostly venous, but this is not invariable. This is readily controlled by packing with gauze wet with very hot salt solution alternately on the two sides, as we work on the opposite side. Few if any vessels require the use of forceps or ligature.

When the entire laminæ have been cleared their removal is the next step. This may present some difficulty at first, especially in the thoracic region where the laminæ are more imbricated. The difficulty lies in effecting the first entrance into the canal, the rest is easy. To effect this entrance one may use a Hudson or Doyen burr or a trephine, others use a bone-cutting forceps, and Bickham recommends a Doyen hand saw, for the entire removal of the laminæ. A quick, safe and easy method is to use a rongeur bent on the edge with a flattened lower blade, beginning along the lower border of the laminæ. With the same instrument, or a more powerful one, the laminæ of three or four vertebræ are removed piecemeal to their outer limit. This is accomplished easily and quickly as soon as an entrance is made into the canal. If a hand saw is used the saw cut must be directed somewhat obliquely inward so as not to saw down into the pedicles. Some use a Gigli saw after an entry is made into the canal, but it is difficult to pass and hence is objectionable. With the use of a rongeur there will be little or no trouble with hemorrhage from the bone, but if the oozing from the bony surfaces is troublesome it may be checked by crushing the surface with a blunt rongeur or the

Digitized by Google

pressure of an elevator, etc., by hot pads or by Horsley's wax. To give room for the operation within the canal and to allow for the possible uncertainty of localization, the laminæ of at least three and perhaps four vertebræ should be removed. But it may be preferable to open the dura after the removal of the laminæ of two vertebræ to see whether the laminæ above or below require removal.

So far the operation has been merely a laminectomy. The ligamenta subflava may adhere to the dura, but are readily peeled off, and the fat surrounding the dura is now exposed. If there is an extradural tumor, it is now exposed if, as is the rule, it lies in whole or in part on the dorsal aspect. If the tumor is extradural we proceed to remove it, removing as many more laminæ in either direction as may be necessary, for extradural tumors, especially cysts, often extend a considerable distance longitudinally within the canal. Care should be taken in separating the tumor from the dura, from which it commonly grows, to avoid injury to the latter, unless on account of its involvement a section of it must be removed. If an opening has been made in the dura with loss of its substance we may try to close it by suturing some of the overlying soft parts to the edges of the defect. Starr advises opening the dura in extradural tumors, as a secondary growth may be found within it, but it is not often done.

Before opening the dura a strong probe or a Horsley dural separator should be used to explore the extradural portion of the canal above or below the opening to make sure that no extradural cause of pressure exists. The compressing masses of cicatricial tissue, secondary to a healed tuberculous process, which have been removed by Macewen, Trendelenburg and others, are extradural in position.

Digitized by Google

If no tumor is found extradurally, we expose the dura by pressing back the fat from either side of an incision in the median line and observe whether or not all the dura exposed pulsates. Lack of pulsation indicates increased intradural tension or shutting off of the arachnoid space at or above the point exposed, by a tumor, cyst, adhesions or some other cause. The dura should be palpated before it is opened, though an intradural tumor is not usually demonstrable before the dura is opened, even if it is situated posteriorly. If the dura feels more tense and elastic than usual, a tumor or some other cause of increased intradural tension probably exists. The dura is opened by the point of a knife and slit up and down in the posterior median line, the length exposed, by a pair of fine scissors. Its margins are held apart by silk retraction sutures, forceps or retractors. The cerebrospinal fluid escapes at first to some extent, sometimes as if under considerable pressure, but it offers no trouble by its continued flow, for it quickly ceases if the part operated upon is made higher than the rest of the spine and the head. In my first case, a tumor in the cervical region, I gently packed off the canal above the site of operation with gauze, but this was found unnecessary in subsequent cases even in the cervical region, though in the neck it is not so easy to give the spine a position higher than the rest of the arachnoid fluid. Schede used and spoke highly of Sick's proposal to pass a temporary elastic ligature outside the dura to shut off the fluid by its pressure, but this is more objectionable than packing off with gauze.

After exposing the cord, it is often not an easy matter to say at once whether there is a tumor present or not, or if present what its exact position and limits are. We can say that the cord does not appear normal and is prominent, but we may not be sure whether this is due to an intra- or an

Digitized by Google

extra-medullary tumor. This is an important point and the cause of this difficulty lies in the fact that, in many cases at least, the arachnoid over the tumor is thickened and presents a number of lamellæ, often œdematous, which must be divided until the tumor or cyst, or both, are exposed. Sometimes one finds localized collections of fluid shut in between these thin lamellæ of arachnoid in the vicinity of a tumor, as in Case IV. Spiller, Munro, Krause and others have described encapsulated collections of cerebrospinal fluid which of themselves caused pressure symptoms, without other cause. In Cases II and V, I found a cyst, whose walls were formed by these lamellæ, about the tumor so that on opening the cyst, the tumor was fully exposed, though in Case V it was evident that a tumor was present in a dorsomesial position as soon as the dura was opened.

As a rule the tumor is on the dorsal aspect of the cord. This was so even in Case IV, where the motor symptoms predominated and the sensory symptoms were slight. The tumor may extend laterally or even ventrally as in Case I, so as to require the division of one or two posterior nerve roots. It is always advised to suture such divided roots, but as degeneration occurs in an ascending direction into the cord from the point of section and as no regeneration occurs in the fibres within the cord, I can see no object in such suture. If repair were to be expected under these conditions, the division of the sensory root of the Gasserian ganglion, proposed by Spiller and Frazier for tic douloureux, would be useless and the small length of the posterior spinal roots resected to cure intractable neuralgia (Abbe) would not insure against recurrence. Moreover the division of one or even of two posterior nerve roots intraspinally would have no serious effect on the sensation of the part supplied, for according to Sherrington and Green-

Digitized by Google

baum a given cutaneous area is supplied not by a single nerve root alone but by the root (or two roots) on either side of it, so it would require the division of at least three successive roots to produce cutaneous anæsthesia. After division of one or two posterior roots the cord may be gently retracted or pushed to the opposite side to give access to a tumor situated anteriorly.

When the tumor is exposed it is commonly found to be encapsulated and can usually be enucleated with only trifling hemorrhage by blunt dissection by the finger, a pair of forceps, a small scoop, or a Horsley's blunt separator. A few firmer strands of tissue may require division and at times one or more small vessels may require ligation by very fine catgut. The tumor, especially if of any size or of long standing, flattens the cord in a scaphoid manner, by bulging into the central part of the flattened area. The separation of the tumor from the cord is the first step in its enucleation and this may involve the division of a thin layer of tissue connecting the coverings of both. At times the tumor is found to grow from or to be so incorporated with one or more nerve roots (usually posterior roots) as to require their resection. To avoid any additional compression of the cord in enucleating the tumor, it may be wise in some cases to remove longitudinal wedge-shaped pieces from the tumor to reduce its bulk. After opening the dura sponging should be done with the greatest gentleness and care and to clear the field of operation drip irrigation with warm normal saline is preferable to sponging. In order to get above and below some of these tumors, we may have to remove two or three more laminæ. Thus in Case IV it was necessary to remove five or six laminæ to reach the limits of the growth.

Digitized by Google

Also if no tumor is found we should not hesitate to remove the laminæ higher up, to the uppermost limits indicated by the slightest changes in sensation. Even five or more laminæ should be thus removed if necessary, for there is less danger of a mistaken diagnosis than in failing to find the tumor. If this procedure is too much for the patient, it may be completed after an interval of a couple of days, as has been successfully done. If the tumor cannot be successfully removed, the posterior nerve roots, at and just beyond the level of the tumor, should be divided. This, together with the removal of pressure by laminectomy, would afford great relief to the patient. If for any reason the cord is to be incised this should be done exactly longitudinally.

The dura should be completely sutured with fine catgut in a round needle to prevent leakage of the cerebrospinal fluid. If a needle with cutting edges is used, I have found (Case II) that leakage may occur through the needle punctures. In only one case (Case V) a small drain of three strands of catgut was left through a small opening of the dura. Some[15] advise incomplete closure of the dura or none at all, to allow free drainage of cerebrospinal fluid. This I consider objectionable unless there is oozing of blood (as in Case V). I have seen the free drainage of this fluid accompanied by a restless irrational condition, which cleared up with the stoppage of the outflow of the fluid. Brodnitz has suggested that it was the cause of the rise of temperature in two aseptic cases and, according to Henle, the free outflow of cerebrospinal fluid has repeatedly been followed by a fatal termination, even without infection. It is always annoying and there is also more risk of infection and of a resulting spinal meningitis, and there is more difficulty in avoiding bed-sores when the back cannot be kept dry. If after the operation there is any evidence or sus-

Digitized by Google

picion of an increase of the tension of the cerebrospinal fluid, it may be relieved by lumbar puncture.

The muscles are brought together with interrupted chromic gut sutures to obliterate any dead spaces, and the thick aponeurosis with a continuous suture of the same material. At the lower angle of the wound a small drain of folded rubber tissue is inserted down to the surface of the dura to drain away any blood or serum for the first twenty-four to forty-eight hours. If a suture is tied to the outside end of this, it may be removed by pulling on the suture without disturbing the dressings. For the skin, a continuous buttonhole suture of silk answers well, but it should be reinforced by three or more interrupted, fignre of eight, silkworm gut sutures through the skin and the edges of the vertebral aponeurosis, which are left in from twelve to fourteen days. This is for the reason that the skin edges are liable to separate, after apparent healing and the removal of the silk sutures, allowing the wound to open up. This occurred in two cases (Cases II and V) in both of which there was some leakage of cerebrospinal fluid, apparently through needle puncture holes in the dura, as a Hagedorn needle was used in suturing. Whether this was due to delayed union on account of natural slow repair in this situation, or on account of trophic disturbances at the site of the wound, or on account of the constant watery discharges, or to the pressure of the body and the lateral strain in case of restlessness (as in Case V), it should be avoided by the use of reinforcing silkworm gut sutures, which may and should be left in longer than the silk sutures, or by substituting for silk horsehair sutures, which can be left in as long as desired.

In the course of the operation the question may arise whether the operation is to be completed in one or in two stages. In Case III we were compelled to suspend the opera-

Digitized by Google

tion after removal of the laminæ and exposure of an extradural tumor on account of the failure of the pulse and respiration. The patient responded to stimulation, artificial respiration and an infusion of 1000 c.c. of normal salt solution. The use of stimulating and nutritive enemata brought the patient into much better condition than before the operation, so that she underwent the second stage, forty-two hours later, much better than the first. In Case IV, the only fatal one in the series, the operation was long and very difficult, the tumor extending under the laminæ of six vertebræ and being very adherent and difficult to remove from the much compressed cord. I have often wondered whether the result might not have been different had we operated in two stages, though the post-operative condition was not entirely that of shock or collapse. The blood pressure, taken from time to time during the course of an operation, would give an indication as to whether the operation should be suspended and completed subsequently or not. The previous and present condition of the patient, the amount of blood lost and the length of time the operation has already lasted also help one to decide whether to operate in one or two stages. There is a very decided advantage in completing the operation in one stage. The increased risk of wound infection alone is enough to decide the question in favor of the one-stage operation, if that is possible. Horsley has advised the two-stage operation in cases of brain tumor, but I do not advise it in intraspinal tumors,[*] as a routine measure, as Brodnitz has done. As an occasional resort in difficult cases or those in poor condition it may be of life saving service. The wound should be temporarily closed. In case we operate in two stages shall or shall we not open the dura in the first stage? Unless the condition of the patient forbids it I would advise opening the dura in the first stage to learn the presence or position of

Digitized by Google

the tumor and the direction in which it extends and to determine whether or what additional laminæ require removal at the second operation. In a recent case operated on in two stages by Dr. Elsberg the tumor appeared at the first operation on opening the dura very much like an intramedullary growth, but at the second operation, the pressure of the cerebrospinal fluid having been relieved for some little time, the tumor was well demarcated from the cord, facilitating its removal. Again in other cases the absence of a tumor might possibly be demonstrated, thus making the second operation unnecessary. The dangers of the opening of the dura, sepsis and excessive loss of cerebrospinal fluid are preventable ones. It adds but little to the time or shock of the operation. The dura should be temporarily sutured to prevent the leakage of cerebrospinal fluid.

The *mortality* of the operation itself was found by Harte[15] in his series of ninety-two cases (including cysts) to be nearly 47 per cent. Among the ninety-six cases of operations on intraspinal tumors collected by Krauss the immediate mortality (within the first twenty-four hours) was 10.4 per cent.; the mortality within the first week 20.8 per cent. and within the first three months 39.5 per cent. Krause gave the mortality 43.7 per cent., and in the last twelve cases 25 per cent. Among the seven cases operated on by the writer, the mortality was 14.3 per cent. This does not include two exploratory operations and one case where the pressure on the cauda equina was due to an endothelioma of the upper sacral vertebræ, in all of which the dura was opened and in all the patient recovered. McCosh has stated that the mortality of laminectomy itself should not be over 10 per cent. Including these three cases the mortality was just 10 per cent.

The chief causes of death are shock and meningitis. The former can be reduced to a minimum by guarding against

Digitized by Google

hemorrhage and operating in two stages, if the laminectomy is not well borne. The shock as a rule is not serious, less so than in operations on the brain. As meningitis is due to infection, it should be avoided by careful technic and the administration of urotropin. Infection is most likely to occur when a bed-sore is present. Hence the presence of the latter makes the prognosis more serious. A bed-sore should be carefully sterilized as described above. Especial care should also be employed in sterilizing the sound skin, in cases where a bed-sore is present, by the free use of Harrington's solution, or by tinctura iodi, used on a dry surface. The danger from the excessive discharge of cerebrospinal fluid is one easily avoided at the time of operation and subsequently by the use of the precautions already mentioned.

The After-treatment.—The patient should be placed at once on an air bed in the dorsal position. As soon as the patient can be moved without much pain, he may be turned on the side for the relief afforded by the change of position. The prone position employed by some is not necessary, neither is any special support for the spine. For the relief of pain in the back and limbs, especially on movement, or of painful cramps, morphine is necessary, perhaps for several days. To prevent the formation of bed-sores the back should be kept carefully clean and dry and if a bed-sore exists its discharge must be kept away from the wound. The latter must also be carefully protected from infection by the discharges from the bladder and rectum. In cases with paraplegia care should be exercised to avoid pressure sores and pressure paralysis. Thus in Case II there developed a peripheral peroneal palsy, which was due to pressure either on the operating table or in bed. The lower extremities were at the time paralyzed in this case. The drainage should be removed early and the re-

Digitized by Google

tention sutures left for at least ten to fourteen days. If there is leakage of cerebrospinal fluid this may be diminished and finally stopped by the pressure of a gauze pad over the line of the incision. If moderate in amount it will probably do no harm, even if it continues for some time, but besides being annoying it increases the danger of bed-sores and of sepsis, as long as it continues. Until the incision is healed, it is wise to continue the regular use of urotropin to keep the cerebrospinal fluid sterile.

After the operation patients should be kept in bed for at least three weeks as a rule, but this period varies from two to six or even ten weeks, according to the special conditions present. In some cases, especially in extradural growths and cysts, the convalescence may be very rapid and the necessary rest in bed equally short. Thus in Case III the patient went home fourteen days from the operation. After the disappearance of the pain and hyperæsthesia, massage is of great service in hastening the functional recovery. Electricity should also be systematically used for the same purpose. During the entire course of the after-treatment, the most scrupulous care should be employed in attending to the functions of the bladder and rectum if these are wholly or partly paralyzed. On this may depend the result of the case, and here is where the nursing art is put to its most severe test. It is quite possible to continue for a year or more with continual catheterization without infection of the bladder, but this is a monument to the skill and carefulness of the nurse. Fortunately most of these cases require catheterization for a relatively short time only, but if this is required at all it must be done with the most scrupulous care. Urotropin should be regularly administered during this period also.

Results.—The *immediate result* depends upon the position of the tumor (extradural or intradural), the duration and de-

Digitized by Google

gree of its pressure on the cord, and the amount of injury of the cord in the removal of the tumor, in spite of the greatest care. In general, immediately after the operation, there is a decided increase of the paralysis present before operation, especially the motor paralysis, and often a paralysis of parts not previously paralyzed. This is due not only to the slight traumatism to the cord, but also to the consequent œdema. In extradural tumors, this increase of paralysis may be nearly or wholly absent and in them the paralysis is usually promptly recovered from as in Case III, where improvement began on the second day and by the fourteenth all but the finer movements could be slowly performed. In intradural tumors the diminution of paralysis may not commence for two weeks, as in Cases I and II, or a considerably longer time, as in Cases V and VI. When once begun the improvement in motion is usually slow and gradual but may continue for a long time. When the pressure of the tumor has lasted a long time the improvement may be particularly slow. In a case reported by Warren,[17] improvement continued five years or more after operation. Of course if the pressure upon the cord has been severe or long continued enough to cause any degeneration, the muscles supplied by the degenerated cells or the cells connected with the degenerated fibres do not recover their lost power, as neither the cells nor fibres of the cord regenerate. The same also holds in the case of the degeneration of sensory fibres. Where there is no such degeneration the paralyses may be entirely recovered from even when they have been complete or nearly so. Those parts improve first and most rapidly which were last and least paralyzed and vice versa. This is a very strong argument for early operation on all intraspinal tumors. In most reported cases the results would have been better if the operation had been done earlier. Very little time should

Digitized by Google

be wasted in trying antisyphilitic treatment, unless the syphilitic history is very definite. Of course even where extensive degeneration has occurred a successful removal of the tumor arrests the progress of the disease and saves life. The sensory disturbances improve before the motor.

Some pain may persist for a time from the disturbance of the posterior nerve roots, but as a rule the root pain is nearly always speedily relieved to a marked degree. In Warren's case, mentioned before, the pain continued for six years, but this is most unusual. Directly after the operation there is often considerable hyperæsthesia but this soon disappears. Passive motion, and later active motion, of the parts paralyzed may for a time occasion severe pains. A spastic condition of the parts most or first affected may persist for a long time or even permanently, owing to a degeneration of fibres of the pyramidal tract, due to the long continued pressure of the tumor, or there may be merely a tendency to cramps. In these cases the deep reflexes remain exaggerated on the side or sides which had been paralyzed.

As to the *ultimate result,* this is favorable so far as my experience goes. Out of the six patients operated on (seven operations), one (Case III) being operated on twice on account of recurrence, none of the five who survived the operation have died as the result of the tumor, with the exception perhaps of Case VI. Although at the time of the second operation in Case III, an absolutely bad prognosis was given, I received a note from Dr. Mailhouse, November 3, 1909, over four years after the second operation, stating that "the patient is practically well, doing her own housework, though she has a spastic condition of the left arm and leg due to degeneration of the pyramidal tracts produced by the long duration of the disease prior to operation, and she carries her head stiffly."

Digitized by Google

This result in spite of the fact that the microscopic diagnosis has usually been some form of sarcoma shows either that such tumors are relatively non-malignant within the spinal canal or that there is a mistake in the pathological diagnosis of these tumors. As an example the tumor in Case I was called a fibrosarcoma by one pathologist and an endothelioma by another. Many tumors formerly called fibro-sarcoma are now called endothelioma and the distinction is largely a matter of terms. The length of time that had elapsed in most cases from the first symptoms to the time of operation is against a high degree of malignancy of most of these growths. It is now quite generally recognized that endothelioma or fibrosarcoma is a form of tumor quite commonly found in the brain and cord, growing most often from the meninges, and showing but little malignancy. According to Starr, intraspinal tumors usually recur, but in nearly or quite half the cases of intraspinal sarcomata in Harte's table of cases removal insured against recurrence, hence their recurrence is less frequent than that of similar sarcomata elsewhere. In my own cases, Case III recurred but did not recur again after a second operation and Case VI may very likely have recurred.

Except in the case of the thickenings due to a healed tuberculous process, the results of operations on intraspinal tuberculous foci are not so good as those from orthopædic and general treatment, for there is danger of recurrence or of setting up tuberculous meningitis, and the lesion is frequently an inoperable one in the cord. I know of no report of a successful removal of an intramedullary growth. As a result of the laminectomy the spine itself may be somewhat stiff in some cases, in others altogether normal.

The six patients on whom the seven operations were done, which form the basis of the surgical part of this paper, were

Digitized by Google

all seen by Dr. Ramsay Hunt and the diagnosis confirmed or made by him. The first six operations have been published in The Transactions of The American Surgical Association, volume XXIV, 1906. They were all operated on in the Presbyterian Hospital.

Case I has also been published in the Medical and Surgical Report of the Presbyterian Hospital, volume VI, 1904, and in The Medical News, October 1, 1904.

REPORTS OF CASES.

CASE I. Extramedullary tumor (endothelioma) of the lower cervical segments, with successful extirpation.

CASE II. Extramedullary tumor (fibrosarcoma) at the eighth cervical and first dorsal segments, with successful extirpation.

CASE III. Extradural tumor (fibrosarcoma) of the upper cervical region (second, third, and fourth cervical segments). Extirpation, followed by recurrence and second operation which was successful.

CASE IV. Extramedullary tumor (fibrosarcoma) of the lower cervical and upper dorsal segments. Extirpation, patient dying three days after the operative procedure.

CASE V. Extramedullary tumor (fibrosarcoma) at the tenth dorsal segment, with successful extirpation.

CASE VI. Extramedullary tumor (fibrosarcoma) of the lumbrosacral region. Extirpation, with relief of pain but recurrence of tumor within a year.

CASE VII. Extramedullary tumor (neurofibroma) at the cervical segment; with autopsy.

CASE VIII. Intramedullary tumor of the upper cervical region, with exploratory operation and evacuation of two drachms of cystic fluid from the interior of the cord.

CASE I (Summary). *Extramedullary tumor of lower cervical segments successfully removed. Onset with pains in the back of the neck and left shoulder, later in the right. Duration of pains one year, followed by flaccid paralysis of the left arm, spastic paralysis of the left leg and dissociated anæsthesia of the opposite side below the level of the third rib. Pathological diagnosis of tumor, endothelioma, Nearly complete restoration of function. No recurrence after 7 years.*

History.—Mrs. S., aged thirty-one, married; no children, no miscarriages. A few months before the onset of present trouble she fell and injured right hip. In October, 1901, was seized with pains in back of neck, later extending into left shoulder, which were very severe and sometimes lancinating. Later the pains were also felt in right shoulder. Six months after the initial pains,

Digitized by Google

sharp lancinations also felt in upper chest below clavicles. One year after pains had made their appearance the left arm became weak and the left leg stiff and awkward. These symptoms progressed gradually and she soon noticed that the right leg was insensitive to heat and cold. Of late there has been a disturbance of the vesical sphincter and a girdle of sensation immediately above the umbilical level. She also has had paræsthesias of both arms, more marked in the left. She states that several months previously the neck had been quite stiff for a time, and movements had increased the pain. This, however, disappeared and has not recurred since.

Examination (January 23, 1903).—The cranial nerves are normal. The pupils are equal and react normally. Movements of the neck are free. There is no abnormality of the spinal column. Sitting up and bending the head forward accentuates the girdle sensation at the umbilical level. Jarring of spine and deep pressure cause no pain. The paralysis of the left upper extremity is distributed as follows: There are normal movements of abduction, external and internal rotation of the shoulder and of flexion and supination of the elbow. Adduction of the shoulder is diminished and there is paralysis of the movements of extension of the elbow, pronation, extension of the thumb and fingers, flexion of the wrist and fingers (with the exception of the flexor sublimis digitorum, which is weak) and of the intrinsic muscles of the hand. There is well marked atrophy of the paralyzed muscles, but no fibrillary twitchings. The circumference of the left arm and forearm is half an inch less than on the right side. No oculopupillary symptoms.

Sensations.—On the entire right side below the level of the third rib anteriorly and the fourth dorsal spine posteriorly there is complete loss of pain and temperature sense, with preservation of the tactile sensibility (dissociated anæsthesia). Corresponding to the upper limit of this anæsthesia there is a hyperæsthetic band which is present on both sides of the trunk. There is a slight but distinct tactile disturbance along the inner side of the left arm and forearm. The deep sensibility of the fingers of the left hand is absent, but in the lower extremities the articular sense of the toes is preserved. The tendon reflexes of the lower extremities are exaggerated, more especially on the left side, which is spastic and in which ankle clonus is present. Babinski reflex present on both sides.

Surgical History.—She was referred for operation by Dr. Joseph Fraenkel of this city, who diagnosed and localized the tumor. The operation was performed February 2, 1903, under ether anæsthesia, with the patient in a prone Sims' position on the left side. The spines and laminæ of the fourth to the seventh (inclusive) cervical vertebræ were removed by bone cutting forceps and a rongeur respectively. There was absence of pulsation in the lower part of the dura exposed. Median incision of the dura. Gauze was inserted between the dura and the cord at the cranial side of the opening which checked the troublesome flow of cerebrospinal fluid. At first nothing was seen except some bulging of the cord opposite the sixth lamina. Here a probe encoun-

Digitized by Google

tered resistance on the left side, where, pressing the cord to the right, a dark bluish prominence was seen anterior to the posterior nerve roots and extending anteriorly. Two posterior nerve roots were cut central to the root ganglia to expose the tumor. After dividing its capsule along the curved line where it was apparently continuous with the pia, the tumor was fairly easily removed by blunt dissection. The tumor was apparently attached at one point to the pia. It measured 2 cm. in length by 1¾ cm. in width and 1¼ cm. in thickness. The dura was sutured with fine gut, the muscles and aponeurosis with chromic gut and the skin with silk. A cigarette drain was inserted to the dura at the lower angle which was removed two days later.

Post-operative History.—After operation the paralysis of the left side was somewhat increased, and there was some weakness of the right side, which cleared up in about ten days. She complained of paræsthesia (prickling), particularly in the upper extremities, and profuse perspiration of the face and neck was very annoying. Healing occurred *per primam*. There was no improvement for two weeks except the disappearance of the paræsthesia and sweating, and the immediate disappearance of the root pains.

On March, 23, 1903, there was no demonstrable anæsthesia corresponding to the posterior roots severed at the time of operation; there had, however, been some paræsthesia which had practically disappeared. Since then steady improvement for a year or two. Motion returned first in the right and then in the left leg. Six years after the operation there remained only a slight weakness of the left hand. The tumor was an endothelioma (Prof. Ewing).

Remarks on Diagnosis and Localization.—The diagnosis of tumor was based upon the onset with lancinating pains, at first unilateral, and always more severe upon the left side, atrophic paralysis of the muscles of the left arm (lower arm type), and the symptoms of progressive unilateral compression of the cord (Brown-Séquard type). The absence of rigidity and tenderness of the spine was in favor of an intradural growth. Of especial interest was the presence of a well-defined dissociated anæsthesia upon the right side of the body below the level of the lesion, which gave rise to some uncertainty as to the intra- or extramedullary seat of the growth. It is possible that the localization of the tumor on the lateral surface of the cord in this case by pressure upon Gower's tract was responsible for the dissociation of sensibility. The duration and severity of the root pains preceding the compression

Digitized by Google

of the cord were in favor of extramedullary growth. Of especial interest was the presence of a girdle sensation at the umbilical level. This association Dr. Fraenkel and I had observed previously in a case of extramedullary tumor on the anterior surface of the cord in the cervical region, so that we were rather inclined to regard it in this case as possessing some significance as an extramedullary symptom. Since then, I have observed this symptom in central tumor in the cervical region. The atrophic paralysis of the arm was attributed to compression of the anterior roots of the sixth, seventh, and eighth cervical, and first dorsal segments. It is interesting to note that oculopupillary symptoms were absent, although the intrinsic muscles of the hands were paralyzed and tactile disturbances were present along the inner side of the arm.

CASE II (Summary). *Extramedullary tumor at the eighth cervical and first dorsal segments, successfully removed. Onset with pains in the back of the neck, the upper portion of the chest and the inner side of the right arm, followed seven years later by similar pains in the corresponding distribution on the left side. Duration of root pains before the appearance of spinal cord compression about ten years. These consisted of weakness of right hand and forearm with atrophy, spastic paralysis of the right leg, and tactile, pain and temperature disturbances below the level of the third rib, more marked on the left side. Pathological diagnosis—fibrosarcoma. Partial restoration of function. No recurrence after five and one-half years.*

History.—Mr. W. M., aged forty-five, manufacturer, single, was admitted to the Presbyterian Hospital September 6, 1904. He is a man of moderate habits. No history of venereal disease or trauma. The present illness began twelve years ago with neuralgic pains in the upper portion of the right side of the chest, just below the clavicle, and along the inner side of the right arm. These pains continued with varying intermissions up to the present time. They are described as intensely neuralgic, somewhat like a toothache in character. Seven years later pains of the same character made their appearance along the inner side of the left arm, as well as the upper portion of the left side of the chest. During this entire time there were no paræsthesia and no weakness of the arms, and he was treated for rheumatism and neuralgia without success. When the pains appeared upon the left side their intensity diminished somewhat on the right. They were often of a throbbing character. For the past year he has had a girdle sensation below the margin of the ribs, and for the same length of time has been impotent and very constipated. He has

Digitized by Google

had a weakness of the vesical sphincter for the past six months and some uncertainty of the rectal sphincter. The girdle sensation is one of a feeling of pressure which comes on at night but has usually disappeared by morning after sleeping. It is increased in the sitting posture and disappears when standing or walking. In July, 1903, while in swimming he noticed that the right leg felt heavy and a little stiff, and this has been growing progressively worse. Occasionally he has paræthesia of the feet, more especially of the right. He says that during the past week the neck has occasionally felt somewhat sore and stiff. This he had not noticed previously.

Examination (August 18, 1904).—Patient can stand and walk, but he drags the right leg which is distinctly spastic; and there is a marked Romberg symptom. Cranial nerves are normal. Pupils are equal and reactions present. The movements of the neck are quite free and cause no pain. There is no tenderness on jarring or direct pressure along the spine. There is a distinct weakness of the flexors and extensors of the right forearm, with slight atrophy along the ulnar sides of both forearms and in the intrinsic muscles of the right hand. Fibrillary twitchings are present in the intrinsic muscles of the hands, inner side of the forearms and the extensors of the forearms and triceps.

Sensations.—The tactile sense is practically abolished below the third rib anteriorly and the fourth dorsal spine posteriorly, as well as along the ulnar sides of the forearms. The pain and temperature sense are very much diminished below the nipples, more especially of the left leg. The deep sensibility of the right lower extremity is very much disturbed. There is a loss of pain and temperature sense along the inner side of the right arm and forearm and a diminution of the pain sense along the inner side of the left arm. There is slight obtunding of the tactile sense along the ulnar sides of both hands. No hyperæsthesia. There is no ataxia of the upper extremities and the arm jerks are present. The abdominal and cremasteric reflexes are absent. The electrical responses in the intrinsic muscles in the hands and in the forearm to both faradic and galvanic currents are practically normal. The right lower extremity is weak in all segments. In the left there is good power but weaker than normal. The tendon reflexes are exaggerated on both sides, more especially the right. Ankle clonus and Babinski are present on both sides.

Surgical History.—Operation September 7, 1904. Anæsthesia, gas and ether. In a prone Sims' position on the left side, a median incision was made from the second thoracic to about the fourth cervical spine. The spines and laminæ of the sixth and seventh cervical and the first dorsal vertebræ were removed. The dura did not pulsate and appeared swollen. There was no spurting of the cerebrospinal fluid until the incision had been carried above the swollen area. On opening the dura, an area firmer and darker than normal was disclosed beneath the seventh lamina. After dividing many layers of arachnoid and a thin bridge of what appeared to be nerve tissue, a cystic cavity was opened disclosing in it a tumor on the right posterior aspect of the cord,

Digitized by Google

extending down beneath the first thoracic lamina. On removal by blunt dissection it measured 3.7 cm. long by 12 x 6 mm. broad. The wound was closed and drained as in Case I.

Post-operative History.—The sutures were removed on eighth day, primary union. Not long afterwards the skin opened up down to the fascia. A few days after the operation there was a free discharge of clear cerebrospinal fluid from the site of the drain until it was checked by the pressure of a pad. It ceased after eighteen days. For the first twenty-four hours the patient was not on an air bed, and notwithstanding the shortness of this period a shallow bed-sore subsequently developed over the sacrum and on each heel in spite of careful nursing. After operation the power of the right leg was completely lost; that of the left leg partly so, and the arms were very weak. The paralysis gradually cleared up so that by the end of the third week the arms were freely movable, though the legs improved more slowly. There was also pain and painful twitchings in the legs and arms, which lasted between two and three weeks, gradually diminishing. September 10 there was sensitiveness to noises and light and distinct oculopupillary symptoms in the right eye. He was catheterized for the first week. There was no increase of the anæsthesia. Much of the time for the first week he was irrational and delirious. A week after operation he was free from root pains. A peripheral peroneal palsy of the left leg was discovered, due to pressure on the operating table or during the early post-operative period when he was paralyzed. The improvement in the lower extremities was slow and steady, and the peroneal paralysis cleared up. He regained sphincteric control. Five years after operation (1909) there is no sign of recurrence, he has no pain and walks with a cane. The right leg is weak and spastic. The microscopic diagnosis of the tumor was "fibrosarcoma, vessels fairly numerous" (Path. Lab. Presbyterian Hospital).

Remarks on Symptomatology.—This case is of unusual interest because of the long duration (ten years) of the posterior root pains. For seven years neuralgic pains were confined to the inner side of the right arm and the upper segments of the right side of the chest, without any weakness or numbness of the extremity. As the pains appeared upon the left side in a corresponding distribution, they diminished in intensity on the right side. This diminution was evidently due to destruction of the root fibres, as objective sensory disturbances were demonstrable along the inner side of the arm. The symptoms of cord compression appeared after ten years of

Digitized by Google

neuralgic pains, and were predominant upon the right side, as was evidenced by the greater weakness and spasticity of the right leg and loss of the deep sensibility of the lower extremity, and the greater anæsthesia upon the opposite side of the body. That fibrillary twitchings in the muscles of the right hand and forearm may be present in extramedullary tumor situated on the posterolateral aspect of the cord, is interesting as it might give rise to uncertainty in regard to the seat of the growth. Twitchings of this character are commonly associated with irritation and degeneration of the anterior horn cells of the spinal cord, and are therefore a common symptom in central tumors. It is possible that the long duration of pain in this case may reflexly have induced an irritable state of the anterior horn cells, with consequent fibrillations. The atrophy which was present shows, however, that the anterior roots must also have suffered from pressure. In this case also a girdle sensation was present in the lower thoracic zones, which disappeared after extirpation of the tumor. This sensory symptom, referable to a much lower level than that of the lesion itself, is in all probability an eccentric or referred sensory symptom from irritation of intraspinal tracts. Although the first dorsal segment of the cord was the seat of compression, oculopupillary symptoms were not observed until after the operative procedure.

CASE III (Summary). *Extramedullary tumor of the cervical region (third, fourth and fifth segments). Operation in two stages. Successful removal of tumor mass. Recurrence in ten months. Second operation with removal of growth, followed by recovery with fair restoration of function. No recurrence after four and a half years. Symptomatology consisted of pains in the neck and shoulders with rigidity, followed two years later by symptoms of compression of cord, paralyses of the arms and legs and mild sensory disturbances. Pathological diagnosis—fibrosarcoma.*

Mrs. C. C., aged thirty-one, was admitted to the Presbyterian Hospital October 27, 1904. She was a patient of Dr. Max Mailhouse, of New Haven, Conn., whose diagnosis and localization of the tumor was confirmed by Dr.

Digitized by Google

C. L. Dana, who saw her in consultation. She has had one child, no miscarriages. No history of trauma.

History.—In January, 1902, she was seized with pains in the back of the neck, radiating into the left shoulder. This pain was severe but not constant and during the paroxysms the head would be drawn down toward the left shoulder, assuming somewhat the attitude in wry neck. These pains would come and go, sometimes lasting two or three months, then disappearing for a time, the longest interval having been three months. Even during this time she was conscious of slight pain in the post-cervical region. She had no pain anteriorly in the cervical region and none in the arms. In January, 1904, there developed numbness in the fingers which gradually passed up the inner side of the left arm. This was soon followed by a weakness in the left hand and shoulder. In March, 1904, the left leg became weak and stiff and has been getting gradually worse. The right leg is also weak, but much less so than the left. At night she is subject to spasmodic contractions of the muscles of the arms and legs. Sometimes all four extremities contract simultaneously and are drawn up together in a flexion attitude. In September, 1904, she experienced difficulty in micturition and for the past few days catheterization is necessary. In August the numbness appeared in the fingers of the right hand. This also was followed by weakness, especially in the movements of the shoulder. Since June, 1904, there is a girdle sensation in the epigastric region, which is constant. There is a transient girdle sensation around the breast, and rarely around the hips. The epigastric girdle is accentuated in the recumbent posture and on standing. It is also increased on turning the head toward the extreme right.

Examination (October 29, 1904).—Cranial nerves are normal. The left pupil is somewhat wider than the right but the reactions are normal. There is no ptosis and no enophthalmos. There is well marked rigidity of the posterior muscles of the neck so that the head cannot be brought forward. Movements of the head to the right are also restricted owing to the rigidity, not, however, toward the left. Backward movements are free. The left upper extremity, except for slight movements in the index finger, is practically powerless. In the right arm slight movement is possible in all segments, but the power is very much diminished. The excursions of the intercostal movement are also diminished. The diaphragmatic breathing is normal. Both lower extremities are paretic, especially the left, which is spastic wth ankle clonus. The Babinski reflex is present on both sides. The epigastric reflexes are absent.

Sensation.—The tactile sensation is slightly disturbed over both upper extremities and the trunk, below the fourth dorsal spine, although no definite areas of anæsthesia can be made out. There is, however, an anæsthetic patch posteriorly over the upper portion of the left scapula. Pain and temperature sense are well preserved over the arms, trunk and lower extremities. There is a band of hyperæsthesia on a level with the clavicles and another on a

Digitized by Google

level with the nipples. Except for the rigidity and some tenderness on pressure of the neck, no abnormality of the spinal column could be detected.

The general condition was poor, the patient having eaten very little for the past few weeks. The diagnosis was made of an extradural tumor at the sixth and seventh cervical segments.

Surgical History.—Operation October 29, 1904, under gas and ether anæsthesia. The spines and laminæ of the fourth, fifth and sixth cervical vertebræ were removed, exposing an oval extradural, encapsulated tumor 3 x 1.5 cm., on the left posterolateral aspect of the dura, opposite the fourth lamina and extending up under the third. The capsule, very adherent to the theca, was opened, disclosing an enucleable tumor, but at this stage the pulse and then the respiration suddenly failed. Artificial respiration and the intravenous infusion of 1000 c.c. of normal salt solution were employed and the patient reacted well to stimulation. The wound was temporarily packed and brought together by a few sutures. Stimulating and nutritive enemata for the next forty-two hours brought the patient into better condition than before the operation.

October 31 the operation was completed. The wound was reopened, part of the third cervical lamina was removed, and the tumor was removed piecemeal by blunt and sharp dissection. The oozing of blood was troublesome and was controlled by hot packing. The tumor seemed to spring from the dura in which a small opening was made, where the capsule was most adherent to it. This was closed by catgut suture. Wound closed as in previous cases. The condition of the patient remained good throughout the operation.

Postoperative History.—About the second day after the last operation she began to move the left hand. Power of motion improved rapidly and by the fourth day, motion, except in the left upper extremity, was nearly normal. By the fourteenth day, when she left the hospital, motion was normal except in the left upper extremity in which all but the finer movements were performed slowly. Pain in the extremities and sudden sharp pain in the wound was severe at first, but on the fourth day after operation it began to diminish, and was practically gone by the thirteenth day. Urination was involuntary for a few days after operation and catheterization was employed. There were no oculopupillary symptoms (the left pupil is still a little wider than the right). The wound healed primarily. She made a practically complete recovery. The tumor was a fibrosarcoma.

A short time after her discharge from the hospital, November 13, 1904, she was practically well, except for stiffness in the left shoulder, and in January, 1905, the adhesions were broken up under anæsthesia and the arm restored almost to normal. There was no pain except occasional darts up and down the neck. Some stiffness of the neck always persisted.

In August, 1905, the first symptoms of recurrence appeared, consisting of pains in the neck and an aching pain in both hands. This was soon followed by weakness of both arms and legs, which gradually progressed. The girdle

Digitized by Google

sensation in the lower thoracic zone reappeared. The symptoms have been symmetrical from the first and gradually progressive.

Examination (October 20, 1905).—Patient can stand and walk without assistance. The arms are weak in all segments, the right more than the left. Movements of the neck are somewhat restricted by rigidity. No ataxia of the arms. Tendon reflexes of the upper and lower extremities are all exaggerated. There is patella clonus on both sides, no ankle clonus. Babinski reflex on both sides. Abdominal reflexes faintly present. Superficial sensations of the trunk and extremities are normal, as well as the deep sensibility of the lower extremities. Pupils are equal. No vesical disturbances. There is a tender point about one and a half inches above the vertebra prominens. The general condition is far better than it was a year ago.

Surgical History.—Operation October 27, 1905, under gas and ether anæsthesia. Incision to the side of the old scar. The seventh cervical laminæ were removed to determine the level of the dura, which was covered by scar tissue above. The latter was readily separated from the dura to the upper end of the old laminectomy opening. The cord appeared flattened on the left side and on careful dissection a tumor 5 x 2 cm. was exposed on the left lateral aspect of the cord. This was removed piecemeal. It was well encapsulated, at least in part, and the capsule on the side toward the dura was removed cleanly, with a resulting tear of the dura, which allowed the escape of considerable cerebrospinal fluid and was sutured. The tumor filled the left half of the canal extending out into two or more intervertebral foraminæ, where it was uncertain whether the tumor was entirely removed. Two or three nerve roots were exposed in the dissection but were apparently uninvolved and unharmed, though superficially scraped. The tumor extended no higher than before but somewhat lower. Wound closure as before, except that several silkworm gut retention sutures were employed, to be left in twelve to fourteen days to avoid the opening up of the wound as in Cases II and V. There was some postoperative shock but she responded to stimulation.

Post-operative History.—There was considerable paralysis of all extremities after operation. She soon began to move the right leg and a little later all the extremities, but recovery was much slower than after the first operation. Considerable pain was complained of in the legs and some in the neck. She sat up November 10, and went home November 12, when both lower extremities were moved well, the right arm was moved freely but was weak, while there was only slight motion in the left arm, which, however, was steadily but slowly improving. The microscopic diagnosis was the same as before, fibrosarcoma.

February 3, 1906: Recovery has been very slow, but has been more noticeable the past two weeks. She can walk with some assistance. The left side is still very weak and she has not yet regained the use of the left hand.

May 23, 1906: The gait has improved so that she walks very well, and can even stand on the left foot alone. There is still ankle-clonus and exag-

Digitized by Google

gerated knee jerks on both sides. The left arm remains spastic and paretic with flexion of the fingers, and she can do little with the left hand. No evidence of recurrence as yet. In view of the first recurrence, a bad prognosis was given, but in this we were wrong, for on November 3, 1909, four years after the second operation, Dr. Mailhouse writes, "Mrs. C. is practically well. She does her own housework and marketing, and goes out daily. She still presents evidence of the degeneration of the pyramidal tracts, produced by the long duration of the disease prior to operation, in a spastic condition of the left arm and leg and carries her head stiffly."

Remarks on Symptomatology.—In this case root pains preceded the onset of symptoms indicating medullary compression, by a period of two years. The pains were in the nuchal region and were bilateral, and when severe, extended into the left shoulder. Very interesting and very suggestive of extradural growth was the accompanying rigidity of the posterior muscles of the neck and the wry-neck attitude during the paroxysms of pain. It will be observed that the backward movements of the head were unrestricted, and the lateral movements only in a slight degree, toward the right side. That this symptom may be entirely absent in extradural tumor of the cervical region, is shown conclusively by a case which I saw in consultation with Dr. David Bovaird in the Presbyterian Hospital, in which an epidural perithelioma was successfully removed by Dr. Joseph Blake.

There was slight tenderness on pressure over the cervical region, but much less than is usual in primary affections of the vertebral column. In this patient a girdle sensation in the epigastric region was observed, as well as transient sensations of constriction about the hips and across the breasts, probably due to irritation of intraspinal tracts.

CASE IV (Summary). Extramedullary tumor of the lower cervical and upper dorsal segments. Operation, removal of tumor; death after three days. Onset nine years ago, without root pains. Gradually increasing paraplegia with sensory disturbances and loss of the sphincter control of the bladder and rectum. Pathological diagnosis—round-celled sarcoma.

Digitized by Google

Mrs. R. A., aged forty-six, was admitted to the Presbyterian Hospital June 12, 1905. She was a patient of Dr. I. Abrahamson and was referred by Dr. C. L. Dana, who has seen her in consultation and confirmed the diagnosis. There was a history of a fall, striking on the vertebra prominens. One brother died of a brain tumor, thought to be due to a trauma.

History.—Nine years ago first noticed numbness and weakness in the ulnar distribution of the right hand and forearm, followed by weakness of the hand. These symptoms have progressed steadily but very slowly. Soon after noticed weakness of the vesical sphincter. Three years ago the right leg first became weak. Two years ago there were, for a time, sharp cutting pains in the right knee varying in intensity, not always present and not increased by use. Soon after this both legs became weak and the knees became stiff, making walking difficult, and finally impossible about nine months ago. For about six months she has had no control of urine, and for the past month no control of flatus. For the past three months, there has been a steady increasing pain in the right submammary region, and recently a girdle sensation, at first on the right and for the past week on both sides. Previous to this she had experienced no root pains.

Examination (June 12, 1905).—The muscles on the ulnar side of right hand and forearm are much weaker than the corresponding muscles on the left. Wasting of the interossei of right hand, less of left, with fibrillary twitchings. Ataxia of the right arm. Wrist and triceps jerks diminished on right, exaggerated on left. Motor power of the lower extremities much diminished, especially on right. Right leg more atrophied than the left. Right thigh and leg flexed, knee contractured, so that patient cannot walk. Knee and ankle clonus exaggerated on the left, but are less on the right (contractures). Babinski on both sides.

Sensation.—Sensibility is diminished along the inner side of the right arm and hand. On the right side from the jaw to the third rib diminished sensibility to touch, below this loss of tactile sensation. On the left side from the jaw to the clavicle there is hyperæsthesia, below this to fourth rib normal, from fourth to fifth ribs diminished sensibility and below this anæsthesia. Right side is anæsthetic to just above the knee, and on the left side to just above ankle. Posteriorly on the right above fourth dorsal spine, diminished sensation, below this anæsthesia; on the left down to the third dorsal spine hyperæsthesia, third to ninth normal, below this anæsthesia. The first dorsal spine is very tender on percussion; the seventh cervical spine is also tender but to a lesser degree.

No control of urine or flatus. Lately there has been pain in the right submammary region and a girdle sensation. The tumor was localized at the eighth cervical and first and second dorsal segments.

Surgical History.—Operation June 14, 1905, under gas and ether anæsthesia. Technic as in previous cases.

Digitized by Google

Operation.—The fifth, sixth and seventh cervical and first dorsal spines and laminæ were removed and later most of the fourth cervical and second dorsal. Exposed dura tense and without pulsation. On opening it a small amount of clear fluid escaped as if under considerable pressure. This fluid came from a cyst overlying the tumor. The latter was elongated and lobulated and lay on the posterior surface of the cord, flattening it, between the upper margin of the fourth cervical and the lower margin of the second dorsal laminæ. The tumor was carefully dissected off the cord by blunt and sharp dissection. Wound closure as in previous cases. During the operation the pulse rose to 120 and there was some cyanosis as the respiration became feeble and irregular, and finally ceased, but it was quickly resumed. An infusion of 1250 c.c. of a 0.09 per cent. salt solution with adrenalin was given on the table. The operation was a long one, lasting over two hours, owing to the length of the tumor and the difficulty of its removal.

Postoperative History.—On recovery from anæsthesia she kept calling for air, but there was no cyanosis or dyspnee. Two days later, breathing was more labored and on the following day, before death, there was cyanosis. Pain was complained of all over the body, and the patient was restless and at times irrational. The wound was dressed on the third day and a considerable amount of cerebrospinal fluid escaped on removal of the drain. In spite of stimulation the pulse and respiration failed and the patient died seventy hours after operation. During the last twenty-four hours the temperature rose, reaching 105, twelve hours before death, but there was no apparent infection. Microscopic diagnosis of tumor: round-celled sarcoma.

Remarks on Symptomatology.—This case is unusual in that the posterior root pains were absent, although the tumor lay on the posterior aspect of the cord and extended from the sixth cervical to the third dorsal segment. It was only in the later months of the disease, the history of which extended over a period of nine years, that lancinating pains were felt in the right mammary region, evidently corresponding to an irritation produced at the lower pole of the tumor. The clinical picture was ushered in by numbness and weakness of the right upper extremity, and the early appearance of vesical symptoms. In this case also, as in Case II, fibrillary twitchings were noted in the atrophied muscles of the right hand. The sharp cutting pains in the right knee were probably eccentric in origin from irritation of intraspinal tracts. An abdominal girdle sensation was also present.

Digitized by Google

CASE V (Summary). Extramedullary tumor at the tenth dorsal segment. Successful removal with practically complete restoration of function. No recurrence after four and one-half years. Symptomatology consisted of localized root pain of seven years' duration, which was then followed by gradual compression of the cord, with spastic paraplegia and marked sensory disturbances. Pathological diagnosis: fibrosarcoma.

History.—Mr. J. S., aged fifty-nine, married, was admitted to the Presbyterian Hospital August 14, 1905. No venereal disease. Trauma to knee and back below the left scapula three months before onset of symptoms. The present trouble began about seven or eight years ago with localized pain in the left side of the back and abdomen, corresponding to the level of the umbilicus. In the earlier years it occurred only at night and in the recumbent posture. It was more or less aching in character with occasional sharp darts. The pain was always unilateral and always limited to the same distribution. It has grown gradually worse during the past few years so that any sudden movement, and even a cough, is sufficient to bring it on. One year ago there appeared a numbness simultaneously in both great toes. This numbness gradually ascended the legs and thighs, eventually reaching the level of the umbilicus. He has also experienced sensations of burning and of cold in the lower extremities. Later there appeared ataxia and weakness of the lower extremities. He has a sensation of constriction in the region of the groins. No pain in the spine.

Examination (August 17, 1905).—Sexual power is diminished and there are slight vesical disturbances. Patient is unable to walk alone. There is a marked Romberg symptom. In the recumbent posture both legs present considerable ataxia. The gross motor power of the lower extremities is diminished, especially on the left side which is spastic, with ankle clonus and Babinski reflex. In the right lower extremity the knee jerk is exaggerated, there is pseudoclonus, no Babinski. Cremasteric reflexes are present and the abdominal reflexes at the level of the umbilicus are much exaggerated, especially on the left side. The umbilicus occupied a central position. The spine was not tender and the movements were free.

Sensations.—Below the level of the umbilicus all sensations are disturbed. The anæsthesia is almost complete in the distal portion of the extremities below the knees, very much diminished between the knees and the groins, and very definitely obtunded between the groin and the umbilicus. On the left side, corresponding to the third lumbar spine posteriorly and the umbilicus anteriorly, there is a well marked band of hyperæsthesia.

Surgical History.—Operation August 28, 1905, under gas and ether anæsthesia. Technic the same as in previous cases. The spines and laminæ of the eighth, ninth and tenth thoracic vertebræ were removed. The tumor, 2 x 1.5 cm., was exposed beneath the ninth lamina, surrounded by clear

Digitized by Google

encysted fluid. It was situated posteriorly but somewhat more to the left, and shelled out easily after ligating and dividing a small vascular pedicle at either end. The wound was closed as in previous cases, save for a drain of three strands of catgut through the dura, on account of slight oozing from the veins of the cord.

Post-operative History (September 2).—Has complained of some pain in and above wound and at times he has been restless. Urination and defecation involuntary to-day for the first time. Drain removed; some watery discharge.

September 4: Sutures removed, primary union. Profuse watery discharge noticed on September 5 and on the following day the entire wound was found opened down to the fascia.

On September 7 his neck was retracted and stiff, he was restless and irrational and temperature and pulse had risen again (T. 103.5° on the sixth), after reaching normal. Discharge profuse, becoming more and more purulent, from the exposed granulating surfaces.

On September 9 there was marked tremor and muscular twitching over the entire body, and the patient was apathetic, restless and irrational.

September 14, the discharge has gradually diminished and the temperature fallen.

September 15, lumbar puncture withdrew one ounce of very faintly turbid fluid which on culture gave non-pathogenic bacilli and cocci, perhaps due to contamination.

September 17, temperature normal. Since lumbar puncture patient has been quiet, more rational and without tremor.

September 19, again irrational. Lumbar puncture, withdrawing four ounces, with similar result. Culture showed saprophytes.

October 2, temperature remittent and when low patient is quiet and nearly rational; when high he is apathetic and has a marked tremor, most marked in the hands. The neck is still somewhat stiff. He has regained control of the rectum and bladder. The wound is nearly healed.

October 22, lumbar puncture, two ounces, fluid normal. Temperature normal and hereafter continued so. Knee jerks normal, no Babinski.

November 9, sat up in chair.

November 13, patient is clear mentally, more cheerful and stronger.

November 16, sensation in lower extremities normal except for muscular sense. Walked about fifty feet. Gait is ataxic. Left leg somewhat weaker than right. Reflexes slightly exaggerated; ankle clonus still present.

November 20, walks with one cane. Discharged improved. The tumor was a fibrosarcoma.

March 10, 1909: Three and one-half years after operation patient can now stand and walk well. No Romberg, no pains, and no paræsthesias. The vesical functions are normal. The left knee jerk is somewhat greater than

Digitized by Google

the right. There is no clonus. The plantar reflexes are normal on both sides. The power of the left leg is somewhat diminished although its general strength is very fair. All qualities of sensations of the lower extremities are well preserved.

Remarks on Symptomatology.—The long history of unilateral root pains, of seven years' duration, limited to the tenth dorsal segment, followed by symptoms of spinal cord compression predominating on the left side, left little doubt as to the diagnosis of tumor and the extramedullary seat of the growth. The abdominal reflexes were greatly exaggerated at the umbilical level, especially on the side of the tumor.

CASE VI (Summary). Extramedullary tumor of the sacral region. Operation with successful removal of tumor. Relief of pain but little or no restitution of function. Probable recurrence about a year later. Symptomatology. Pain in the small of the back, left hip and left perianal region for three years, followed by weakness and sensory disturbances in the left lower extremity with loss of the sphincter control of the rectum and bladder. Pathological diagnosis: fibrosarcoma (glioma?).

History.—Mr. F. N., aged fifty-eight, a manufacturer, was admitted to the Presbyterian Hospital November 13, 1906. He is a patient of Dr. S. A. Lewis, of Springfield, Mass., and was seen by Dr. C. L. Dana in consultation. No history of trauma and no positive venereal history. Present illness began in the summer of 1900 with pains in the small of the back, particularly on stooping and on movements of the spine. For three years pains remained about the same, after which they grew worse so that jarring or any sudden movement was quite painful. Pains are directly in the median line of the back and do not radiate into the sides. A few months later, pains developed in the left hip and gradually extended down the posterolateral aspect of the left thigh. These pains were very sharp and intense but varied considerably in their intensity. Pains were soon followed by numbness of the left thigh and external genitals, and to a less extent on the opposite side. The pain in the small of the back was the sole symptom for three years, and very soon after the pains appeared around the left hip and thigh there followed weakness in the lower extremities and some vesical disturbances. The pain is particularly distressing in the left scrotal and perineal regions and in the left gluteal fold. When a severe paroxysm of pain appears he finds the greatest relief in the upright posture. During these paroxysms the numbness appears over the right thigh. First he had difficulty of micturition and this was followed by incontinence. For the past year he has been unable to control either his urine or his fæces.

Digitized by Google

Examination (November 13, 1906).—Patient stands on the right leg, the left leg resting gently on the floor, slightly flexed at the knee. There is slight scoliosis. Bending movements of the spine are very fair, with perhaps a little stiffness in the lumbar region. There is no visible atrophy of the muscles of the legs or of the gluteal region. All movements of both lower extremities are weak, but especially the left. This weakness is especially evident in the movements of the hip. Both knee jerks and both Achilles jerks are absent. The plantar reflexes are present but are diminished on the left. There is no Babinski. The spine is tender from the first to the fifth lumbar, more so over the third, fourth and fifth lumbar spines. There is no one spot of excessive tenderness. Rectal examination is negative. There is no Romberg symptom. He walks fairly well, but the left leg is not moved as freely as the right. The urine dribbles away constantly and is very turbid.

Sensations.—There is a well marked anæsthetic area over both buttocks, extending down the posterior surface of the thighs to about the knees, more marked on the left side. The sensations are also lost over the left hip and are diminished over the outer side of the left thigh, leg and foot. The scrotum, penis and perianal region are anæsthetic on the left side.

Surgical History.—Operation November 15, 1906, under gas and ether anæsthesia. Technic the same as in other cases. The spines and laminæ of the twelfth dorsal and first and second lumbar vertebræ were removed. Pulsation of dura not visible, but palpable. On opening dura, an elongated tumor, not attached to dura, was exposed extending from opposite the spine of the twelfth to nearly opposite that of second lumbar vertebra. Part of the eleventh dorsal and third lumbar laminæ had to be removed to insure complete removal of the tumor. The latter was situated posteriorly and was apparently composed of an upper smaller pinkish and a lower elongated yellowish-white cystic portion. Through the latter part passed two posterior nerve roots, which had to be divided in the removal of the tumor. A couple of small vessels from above required catgut ligature. Wound closed without drainage of dura and with reinforcing silkworm gut sutures.

Post-operative History.—He complained of much pain in the left ankle for the first two or three days. There was also considerable abdominal distress which disappeared only gradually. The urine and fæces were passed involuntarily.

Examination (December 5).—All pains have disappeared except around the anus and perineum, which is similar to that he felt before operation. The left leg is moved in all its segments, but is still considerably weaker than the right. Cremasteric reflexes not elicitable. Plantar reflex still diminished on the left. The sensations of the entire left leg are practically abolished, including the deep sensibility. Sensation on the right side is normal with the exception of an area corresponding to the right side of the scrotum, penis and perianal region. The right knee jerk is active, the left is still absent. Both Achilles jerks absent.

Digitized by Google

Allowed to sit up after fourteenth day. December 12, has attempted to get about with walking machine and crutches. He is gaining slowly in control of left leg. There is an area of partial anæsthesia in the sole of the left foot extending up the inner side of the leg, also a saddle-shaped anæsthetic area involving the perineum and buttocks. Wound healed by primary union. Went home December 14, 1906. Pathological examination of tumor, fibrosarcoma (glioma cells probably, but neuroglia stain failed, perhaps due to delay in sending tumor to laboratory). A letter from Dr. S. A. Lewis of Springfield, dated November 9, 1909, says: "The only benefit derived from the operation was the relief from pain, which had been excruciating. There was no improvement in the paralysis or in the control of the sphincters. In the winter of 1907-08 (somewhat over one year after operation) the pains began to recur, with soreness, and it seemed to me the tumor might be recurring. In March, 1908, he was taken one day with severe vomiting, the next day he developed hemiplegia and coma, dying on the second day after. The urine was free from signs of nephritis at this time." There was no autopsy.

Remarks on Symptomatology.—The earliest symptom in this case was localized pain in the lower lumbar region, limited to the median line of the back. It is very probable that this pain was a symptom of meningeal irritation, as during this time there were no referred pains in the region of the perineum, hips, or lower extremities. After the lumbar pain had persisted for about three years, lancinations appeared in the distribution of the lumbosacral nerves on the left side, and were soon followed by paræsthesias, weakness of the extremities, and incontinence of the sphincters. The absence of both knee-jerks showed that the pressure effects on the cord extended as high as the third lumbar segment.

Case VII. Patient was admitted to Bellevue Hospital on February 1, 1905, in the service of Dr. George Woolsey,[13] and was seen in consultation by Dr. Ramsay Hunt.

Summary.—Extradural tumor (neurofibroma) at the fifth cervical segment, complicating generalized dermal neurofibromatosis (Recklinghausen's disease); onset with lancinating pains in the shoulder, followed in six months by symptoms of compression of the spinal cord. Because of extreme weakness and emaciation, operation was impossible.

Family History.—Ten children, six of whom are dead; four died in early life, one brother the result of an accident, and one sister of heart disease. The other three children are living and well; all are married and have healthy children.

Digitized by Google

The patient was the sixth child and had always enjoyed excellent general health until the onset of the present trouble. He was always somewhat backward mentally, and solitary and peculiar in his disposition. He is of Irish extraction and his parents were not related.

There is no family history of tuberculosis, neuropathic tendencies, or of congenital marks or moles.

The patient is of unusually short stature, and as I have already stated, is backward mentally. He is shy and very easily frightened; has never had friends, and never learned to read or write. He is not alcoholic, but has smoked cigarettes to excess. For the past sixteen years he has worked in a wood-yard, earning $5.00 a week. He is good natured, and is not subject to outbursts of temper.

The multiple fibromata of the skin, which now cover the surface of his body, first manifested themselves about the fourth year, and have been steadily increasing in size and number ever since. He has never had any pain in them, and his mother is quite certain that they were not present at birth (see Fig. 1).

History of the Present Illness.—Present illness began one year ago, with pains in the left shoulder and left leg. The pain in the shoulder was sharp and lancinating in character, and was soon followed by sensations of pins and needles in the left upper extremity. Six months later, there was weakness of the left arm and soon after the left leg became similarly affected. These symptoms of weakness on the left side increased gradually, and were followed in the course of two months by weakness of the right leg, when vesical symptoms also made their appearance. There has been a steady progression of the paralysis, with loss of sensation, complete incontinence of the sphincters, and the development of extensive bed-sores.

Examination (February 1, 1905).—Patient is of small stature, and very fragile skeletal development, except the head which is large and square. There is an extraordinary development of neurofibromatosis nodules of the skin, covering the face, trunk, back and arms. They vary in size from a pin to a cherry. The pupils and cranial nerves are normal. Movements of the neck are free. No deformity or tenderness of the spine. The motor power of the left arm is almost abolished; external and internal rotation of the shoulder are, however, still present, but are very weak. Abduction and adduction are barely indicated by muscular contractions. There is also slight flexion of the elbow, which includes the supinator longus, but the paralysis of the extensors of the elbow and of the muscles of the wrist and fingers is complete.

In the right arm, movements of the shoulder, as well as flexion of the elbow, are preserved but weak; but there is a complete paralysis of the extensors of the elbow and of the muscles of the wrist and fingers.

The musculature of both hands and forearms is atrophic, but no fibrillary twitchings are observed. Breathing is purely diaphragmatic.

Digitized by Google

The left leg is paralyzed, with the exception of slight flexion of the left knee. The right leg is also paralyzed, save for flexion movements of the leg and weak flexion and extension of the foot.

Both legs are fixed in a flexed position and the knee-jerks are not elicitable (possibly because of the extreme flexion contracture). The left Achilles-jerk is present, but there is no clonus. On the right side, ankle clonus is present. Babinski's reflex is present on both sides. Abdominal reflexes are absent.

Shockingly large deep bed-sores are present over both hips and the sacrum, exposing the bony structure in all three localities, and discharging freely.

Careful examination of the peripheral nerves accessible to palpation fail to reveal any nodulations or varicosities, although the nerve-trunks themselves seem hard and thickened.

Sensations were somewhat difficult to test, because of the mental state of the patient and his deplorable condition. There was, however, complete absence of pain, temperature, and tactile sensation as high as the third rib, anteriorly. There were also paræsthesias in the upper extremities, and the tactile sense was blunted, but the exact area on the arms could not be demarcated.

Note.—While the diagnosis, neurofibroma in the cervical region compressing the spinal cord, seemed reasonable, the condition of the patient precluded any attempt at operation.

In spite of careful nursing and care, the patient died on March 4, 1905. Permission was obtained to remove only the spinal cord and a few of the skin tumors, so that the condition of the brain and cranial nerves and the peripheral nerve-trunks could not be ascertained. A few of the posterior ganglia were removed with the spinal cord, but these were not enlarged.

At the level of the fifth cervical segment, a small rounded tumor the size of a hazel-nut was found outside the dura, at the junction of the anterior and posterior roots. It was pearly white in color and was encapsulated. On removing the dura, it was found that the tumor fitted into a depression on the anterolateral surface of the cord. Passing into the tumor was the anterior root of the fifth cervical nerve, the posterior roots passing over the surface of the tumor and being lost in its capsule. All the other nerve-roots were normal to the naked eye and presented no swellings or varicosities (see Fig. 2).

Histological Examination.—The spinal cord examined at various levels showed the typical secondary degenerations, above and below the level of the lesion—more marked upon the left side. There were no evidences of neurofibromatosis in the nerve-roots or in the strands of the cauda equina.

Remarks.—This case is recorded because of the comparative rarity of the pathological lesions, and as an illustration of the diagnostic importance of cutaneous fibromata when asso-

Digitized by Google

Fig. 1

CASE VII.—Extensive neurofibromatosis of the skin (Recklinghausen's disease) in a case with compression paraplegia from a neurofibroma at the fifth cervical segment.

Digitized by Google

Fig. 2

CASE VIII.—A solitary extradural neurofibroma at the fifth cervical segment in a case of Recklinghausen's disease. The dura mater has been cut away and the tumor left *in situ*.

Digitized by Google

ciated with symptoms referable to the spinal cord. The tumor was correctly localized, and could have been removed with ease by an operative procedure had the general condition of the patient justified it. The small stature and low grade of mental development which were present have occasionally been noted in Recklinghausen's disease.

Histological examination of the spinal cord, including its roots, the cauda equina, and several spinal ganglia, fail to reveal any evidences of neurofibromatosis, with the exception of the tumor which had compressed the fifth cervical segment. So far, therefore, as the spinal axis is concerned, it was a solitary manifestation of the neurofibromatosis. Unfortunately, the brain and peripheral nerves were not available for examination. A solitary neurofibroma of the spinal axis as a complication of a generalized dermal neurofibromatosis may occur, but usually the tumors are multiple and are associated with varicose thickenings and nodosities of the nerve-roots. A case of this description I have already reported in detail,[13] —one in which an intravertebral neurofibroma in the cervical region had produced a complete destruction of the cord. In addition to this single large growth, all of the anterior and posterior roots in the cervical region were the seats of nodular tumor formation, and many of the spinal ganglia were similarly involved. There was also extensive neuro-fibromatosis of the peripheral nerve-trunks, and a large plexiform neuroma was situated in the subcutaneous tissues of the lower abdominal region.

CASE VIII (Summary). Intramedullary tumor of the upper cervical region, fourteen years' duration. Onset with pain, lasting three years, followed by progressive spastic paralysis of the left arm and leg, and a contralateral anæsthesia (Brown-Séquard paralysis); slow progression of symptoms, with gradually increasing weakness of the left side, and ataxia and anæsthesia of the right.

Digitized by Google

Exploratory Operation.—Third, fourth and fifth cervical laminæ removed. Cord normal but somewhat swollen. Evacuation of two drachms of cystic fluid from the interior of the cord on its posterior aspect.

[Referred to Dr. Ramsay Hunt by Dr. H. S. Paterson, of New York.] Woman, aged thirty-six, nurse-maid by occupation. No history of injury.

History (October 17, 1907).—Her present illness dates back twelve years and began with shooting pains in the posterior aspect of the left shoulder. In the course of a few months, similar pains appeared in the corresponding region of the right side, but they were never quite so severe as on the left side. These pains lasted in all about three years, with occasional intermissions and varying considerably in their intensity. They gradually subsided and finally disappeared; during this time she was treated for rheumatism.

Soon after the pain in the shoulders appeared, she had pains in the knees on both sides, lasting for several months, which were of the same sharp and shooting character.

Nine years ago, i. e., about three years after the onset of the shoulder pains, the left arm became weak, and a little later the left leg was similarly affected. The paresis of the left arm and leg has gradually increased, more especially during the past year, and is accompanied by increasing stiffness of the muscles.

For some years she has noticed that there is absence of perspiration on the left side of the body.

One year ago, numbness and prickling sensations were first noted in the right foot; these have gradually ascended the leg to the hip. In bathing, she has noticed that the right leg was less sensitive to heat than the left. A few weeks ago, the fingers of the right hand became numb. There have been no vesical symptoms at any time.

She has always been constipated, but more of late; there is no girdle sensation. She has no pain in the spine, and the left side of the body is quite free from paræsthesias.

Examination (October 17, 1907).—Station normal, but the gait is typically hemiplegic. There is a well-marked spastic paralysis of the left arm and leg, with exaggeration of the tendon reflexes and ankle clonus.

The tendon reflexes are also exaggerated on the right side, on which ankle clonus is also present. Babinski is present on both sides. The abdominal reflexes are absent. There is a slight atrophy of the muscles of the left shoulder, and distinct fibrillary twitchings are present in the left trapezius muscle, as well as in the second and third intercostal spaces on the left side.

The spine is mobile and absolutely free from any tenderness or rigidity. There is a distinct kyphoscoliosis in the cervical and upper dorsal regions, the convexity directed toward the left. The percussion note over the cervical region shows no dullness. The neck muscles on the left side are somewhat spastic.

Digitized by Google

Sensations.—The superficial sensations on the left side of the body are entirely normal, with the exception of the neck, where a zone of dissociated anæsthesia is intercalated between the lower margin of the jaw and the clavicle, anteriorly, and the lower occipital region and the spine of the scapula, posteriorly.

On the entire right side of the body there is marked disturbance of sensation below the ramus of the jaw, anteriorly, and the occiput, posteriorly, involving the pain and temperature sensibility; tactile sensibility is also disturbed on the right side; but in a lesser degree, and chiefly over the distal portions of the extremities, *i. e.*, below the wrist and knee.

The deep sensibility of the hands is normal; there is no ataxia of the arms and the articular sense of the toes is undisturbed on both sides. Sensation of the face is normal.

Pupils are equal and react normally; no oculopupillary symptoms.

The probable diagnosis of a central gliosis of the spinal cord was made; as the patient was able to pursue her occupation as nurse-maid, and suffered no pain, an exploratory laminectomy was not urged. She was therefore placed alternately upon iodides and arsenic.

December 20, 1907: Patient has had no pain since last examination. No vesical symptoms.

For the past two weeks, she has felt a unilateral girdle sensation on the right side at the umbilical level, which increases in the recumbent posture.

The objective examination is unchanged, except that the left hand and arm are somewhat weaker, and the numbness of the right hand is more constant and annoying.

May 29, 1908: Patient is still free from pain; girdle sensation has disappeared. There is constant and increasing paræsthesia of the right hand. She has continued her occupation as nurse-maid and is still able to sew and work with the right hand. The objective examination practically unchanged.

March 17, 1909: For some weeks, patient has again experienced the unilateral girdle sensation on the right side at the level of the umbilicus, which was previously noted. No pain and no vesical symptoms. The cranial nerves are negative, and the objective examination remains unchanged. It was noted that the erector pili reflex is absent on the left side.

October 24, 1909: For the past two months the right hand has been stiff and awkward. The functions of the right leg, except for increasing paræthesias and sensory loss, are unimpaired. She has experienced occasional sharp twinges of pain in the upper right intercostal region, but neither constant nor severe.

February 6, 1910: The right arm and leg are both worse. It is impossible to use the right hand now for sewing and finer work, and she was forced to abandon her occupation two months ago.

Digitized by Google

There is astereognosis of the right hand and the deep sensibility of the toes on the left side is abolished, but is present on the right. Numbness of the left leg is now present, which has ascended to the knee.

Examination.—Station shows slight Romberg. Spinal hemiplegia of the left side has increased. The cranial nerves are all normal; the optic discs are negative. Percussion of the cervical spine reveals no tenderness and no change in the percussion note. Fibrillary twitchings are present in the trapezius and supra- and infraspinatus muscles on both sides. No oculo-pupillary symptoms are present. The erector pili reflex is absent on the left side of the trunk, and occasional jumping and starting spasms occur in the extremities at night. No vesical symptoms.

Sensation.—The superficial sensations are very much as noted in previous examinations. There is anæsthesia from the level of the jaw, anteriorly, and from the lower occipital region, posteriorly, throughout the entire right side, which is complete over the distal portions of the extremities and the right side of the trunk and neck; it is less marked along the inner side of the arms and thighs.

The sensations of the left side of the body are normal, except for a strip of anæsthesia between the jaw and clavicle, anteriorly, and occiput and spine of the scapula, posteriorly, where the loss of pain and temperature sense is complete, and the tactile sensation is diminished but not lost.

There is marked astereognosis of the right hand. The deep sensibility of the toes on the left side is lost, but is preserved on the right.

There is a slight hyperæsthetic zone along the lower jaw on both sides and across the upper thoracic region (second and third ribs).

An exploratory operation was performed at Dr. Hunt's request, on March 28, 1910, by Dr. Woolsey. The third, fourth and fifth laminæ were removed; the dura mater was swollen and there was no pulsation. After incision of the dura, there was a copious discharge of cerebrospinal fluid—about four ounces. In the middle of the bone wound and a little to the right of the medium line, a dark and somewhat discolored spot appeared on the posterior aspect of the cord; its surface was smooth and covered by pia mater. The cord was swollen, but no other abnormalities could be detected. A puncture was made over the discolored area near the median line, and about two drachms of clear fluid escaped, and as it flowed out, the posterior aspect of the cord collapsed. The walls of the cavity, from which the fluid escaped. seen through the small puncture which made made, appeared of a brownish hue. The anterior and lateral regions of the cord and the nerve-roots were normal to the naked eye.

Examination (April 8, 1910).—Has made a good recovery from the operation. Had considerable pain in the shoulder for the first few days, and there was some weakness of the right arm, with increased weakness of the left

Digitized by Google

arm and leg, which has rapidly improved. She has good control of the sphincters; there are no oculopupillary symptoms. Sensory symptoms unchanged.

Remarks.—The diagnosis of a tumor growth seemed clear from the occurrence of root pains in a circumscribed distribution, followed by symptoms of unilateral compression of the cord, gradually progressing. It was, however, by no means easy to determine whether the growth was extra- or intramedullary in origin. In favor of a tumor without the cord and compressing it were the initial pains covering a period of three years, a Brown-Séquard paralysis of very gradual development, and the extremely long and progressive course of the disease (about fourteen years). Central tumors (slowly growing glioma and gliosis) may, however, present a very similar picture, and this was regarded as the probable diagnosis. There were, however, no trophic disturbances, and the anæsthesia was not of the dissociated type, save the strip on the left side of the neck between the jaw and the clavicle. The fibrillary twitchings which were present may also occur in extramedullary tumors, so that great weight could not be attached to their presence, and, in a hemiplegia of such long standing as had existed in the case, a kyphoscoliosis, so common in syringomyelia and spinal gliosis, would not have much diagnostic significance. As the condition of the patient grew worse and the right hand became seriously involved, she decided to submit to an exploratory operation. It is, as yet, too soon to say how great a benefit will be derived from the evacuation of the cystic fluid within the cord. The recovery from the operative procedure was rapid, and the initial operative paresis soon wore off. It is interesting to note that the girdle sensation disappeared after the operation.

Digitized by Google

CASE IX (Summary).—*Melanoma of the sacrum, with compression of the cauda equina.*

Onset, September, 1906, with pains in the distribution of the third, fourth and fifth sacral segments on the right side, followed by paraesthesias, diminution of the right knee-jerk and loss of the Achilles-jerk on the right side. In addition there was deep-seated bone pain and tenderness over the sacrum, the right tuber ischii, and the right side of the pubes.

Exploratory operation (by Dr. Woolsey).—*Removal of the first, second, and third sacral and fifth lumbar segments, which were found red and softened, and the seat of tumor infiltration. The patient made a good recovery from the operation, but died two months later, greatly emaciated, with paralysis of the lower extremities and incontinence of the sphincters.*

History.—The case was referred to Dr. George Woolsey by Dr. A. F. Warren of Chicopee Falls, and was seen in consultation by Dr. Dana and Dr. Hunt. He is sixty-eight years of age, and is a retired seafaring man. He was admitted to the Presbyterian Hospital on April 12, 1907. The symptoms of his trouble began in September, 1906, with pain in the right perianal region. This pain grew steadily worse and became a constant soreness and aching, so that he was forced to sit almost entirely upon the left side. He had been a sufferer from hemorrhoids for some years, and it was supposed that his pains were due to this cause. An operation for the relief of hemorrhoids was then performed in Chicopee Falls, but after a transient period of relief the pains returned with increased severity, and in addition to the constant aching pain in the perianal region, he also experienced lancinations down the back of the right thigh and over the right side of the buttock. He occasionally has deep-seated pain over the right inguinal region. In the course of a few weeks there appeared paresthesias in the right perianal region, and the posterior surface of the right thigh. The genitalia also became numb, and he did not have proper control over the sphincters of the bladder or of the rectum. The sexual power has also failed and he is now impotent. There was little or no sensation of urine passing through the urethra and the passage of fecal matter was not attended by the customary sensations. There is some numbness over the left buttock as well. He has lost about 20 pounds in weight during the past few months. In December he commenced to limp badly with the right leg. When the pain is severe, he gets most relief by standing; in the recumbent posture, he lies with the right leg flexed.

Examination (March 5, 1910).—Patient is a small, poorly nourished man, is emaciated, and considerably prostrated by his illness. He is able to stand and walk, and the motor power of the lower extremities is good. The spine is normal in appearance and in mobility. There is a distinct area of tenderness over the upper portion of the sacrum. There is also deep-seated bone tenderness over the right side of the pubic arch, the right tuber ischii, and over the middle of Poupart's ligament. The movements of the hip-joint are free and unrestricted; there is no tenderness along the nerve-trunks. The

Digitized by Google

right thigh and right leg are one-half inch less in circumference than on the left side, but the gross motor power is well preserved. The knee-jerk is diminished on the right side, and the Achilles-jerk is lost. The plantar, abdominal, and cremasteric reflexes are all present and normal.

Sensations.—There is a longitudinal strip of anæsthesia which extends along the posterior aspect of the thigh in the distribution of the third sacral segment. The tactile sensibility of the external genitalia and perianal regions is diminished. Rectal examination shows a relaxed sphincter, and, upon the right side of the pelvic wall near the sacrosciatic notch, there is felt a firm nodular body, freely movable, which suggests an enlarged gland. The bony structures are normal to the touch.

Examination of the urine for Bence-Jones albumin yielded a positive reaction on several occasions; at other times the tests were negative.

On March 16, 1910, an exploratory operation was performed by Dr. George Woolsey at the Presbyterian Hospital. The spines and laminæ of the three upper sacral and the fifth lumbar vertebræ were removed. On exposing the sacrum, the bone was found to be softened, spongy, and red in color, so that it could be easily scooped out and scraped away with a curette, and was very evidently diseased. The dura mater was incised, and a free flow of cerebrospinal fluid took place. The roots of the cauda equina were found to be normal, and a probe passed up the canal for two or three inches met with no resistance.

Pathological diagnosis of tumor was melanoma.

Note.—The patient made a good recovery from the operation, the wound healing by first intention. After the operation the pain was somewhat less, but the anæsthetic area remained unchanged. He was discharged from the hospital on April 12. Dr. Warren, his family physician, informed us that soon after the patient returned home, the pain increased and the right leg became paralyzed. Later the left leg was similarly affected, and there was complete incontinence of urine. He was unable to assume a sitting posture on account of the very severe sacral pain. He died six weeks after leaving the hospital, greatly emaciated.

Remarks.—It was very evident from the sacral pain and tenderness, as well as tenderness over other bony structures of the pelvis, that we were dealing in this case with a tumor of the sacrum, which had compressed the strands of the cauda equina. The pains were so intense and intolerable that an operation was deemed advisable for the relief of pressure. The result, however, was not very satisfactory.

Digitized by Google

REFERENCES.

[1] Starr: Tumors of the Spinal Cord, Am. Jour. of Med. Sc., June, 1895.

[2] Collins: Spinal Cord Tumors, Med. Record, 1902.

[3] Schultze: Mit. aus dem Grenzgeb. der Med. u. Chir., 1903, S. 153.

[4] Oppenheim: Mit. aus dem Grenzgeb. der Mid. u. Chir., 1905-6, S. 640.

[5] Bailey: Jour. Amer. Med. Assoc., 1910, p. 849.

[6] Oppenheim: Beitrag zur Diagnostik und Therapie der Geschulste im Bereich des Zentralen Nerven Systems. Berlin, 1907.

[7] Spiller, Musser and Martin: Univ. of Pa. Med. Bull., Vol. XVI, 1901; Schmidt, Deut. Zeit. f. Nervenheil., Bd. XXVI, 1904; Krause, Berl. klin. Woch., 1906, No. 38.

[8] Oppenheim: Mit. aus dem Grenzgeb. der Med. u. Chir., 1905, Vol. XV, S. 640.

[9] Auerbach-Brodnitz: Mit. aus dem Grenzgeb. der Med. u. Chir., Bd. XV, 1905.

[10] Mit. aus dem Grenzgeb. der Med. u. Chir., Vol. X, 1902, S. 673.

[11] Communication from Dr. Mailhouse.

[12] Reported by Dr. Hunt at a meeting of the N. Y. Society of Internal Medicine, January, 1906.

[13] Fraenkel and Ramsay Hunt: Medical Record, 1903, June 13.

[14] Crowe: Johns Hopkins Hospital Bulletin, 1908, Vol. XX, No. 217. April, 1909.

[15] Harte: Annals of Surgery, 1905, XLII, p. 524, et seq.

[16] Centralblatt. f. Chir., Beilage, p. 37.

[17] Trans. American Surgical Association, 1905, p. 129, et seq.

Digitized by Google

XXIX.

AN EXTRAMEDULLARY TUMOR OF THE SPINAL CORD, APPARENTLY CAUSED BY TRAUMA.*

By David Bovaird, Jr., M. D., Associate Visiting Physician,
and
M. G. Schlapp, M. D., Lately Neurologist to Out Patient Department.

In recent years observations on trauma and subsequent tumor formation reported in the literature have become more frequent, and are establishing more firmly the idea that trauma is unquestionably an etiological factor in the development of tumors.

The following case is one that can be added to the already large number of cases in which the development of a tumor could be traced directly to a trauma.

C. H., age 21, student in a Southern college. Family history negative as to nervous or mental disease.

Personal History.—The patient lived in India eight years, until one year, before his accident. He has always been active, and athletic, playing football and baseball. When a child he had measles—typhoid fever ten yers ago, pneumonia six years ago. He has had no cough, no hemoptysis, no night sweats nor chills. His appetite is always good and his bowels are regular. He denies having had any venereal disease. Five years ago he had a small sore on the penis, lasting one week, which he thinks was contracted in the gymnasium, as a number of other students were also troubled with the same condition. No secondary symptoms ever appeared.

In October, 1908, while playing a game of football the patient was hurt in a scrimmage and immediately afterward felt an infense pain in the region of the spine between the shoulder blades. This pain was so severe that it was impossible for him to remove his clothes without assistance. The pain continued for a week and deprived him of most of his sleep during this time, and

(*Reprinted from The Journal of Nervous and Mental Disease, April, 1911.)

Digitized by Google

then gradually subsided. Ten days later, the patient entered a broad-jump contest and when he ran to the board and tried to jump, he lost power in his legs and fell to the ground. The legs were not stiff but he could not move them as rapidly as before. At the same time he noticed a sensation of numbness in his toes, apparently without loss of sensation. The spastic condition and numbness gradually increased and he came to the Presbyterian Hospital in New York City, September 1, 1909, about eleven months after his injury, presenting the following condition:

The patient can walk with great difficulty. Both legs are very spastic and distinctly weak, the right more so than the left. He complains of numbness in the legs extending up over the body to a level about an inch above the nipple. During the last five months he has had some difficulty in starting urination. His bowels, however, have moved daily without catharsis and there has been no trouble with the sphincters. The patient has had no shooting pains nor gastric crises; no sores of any kind on the body. Since the injury he states that in jarring himself or bending over forward he feels a decided pain between the shoulders at the point where he first felt the pain after injury. He has ankle clonus on both sides, Babinski on both sides, knee jerks very much exaggerated; the cremasteric and abdominal reflexes are difficult to elicit. There is no muscular atrophy. Sensory disturbance involves particularly the pain and temperature senses. He feels the touch of a finger anywhere on the legs, abdomen or back. He recognizes the position of his toes, feet and legs. In some places on the legs and abdomen below the nipple, it is difficult for him to recognize the prick of a pin other than as a touch. In other places, however, he experiences pain when pricked with a pin. The temperature sense is also disturbed in some places. He does not recognize cold or heat, sometimes calling a hot test tube cold, sometimes a cold, hot.

The patient was observed and carefully examined from time to time. The knee jerks became more exaggerated, the ankle clonus more exaggerated and the sensory disturbance continued to increas so that he lost the pain and temperature senses more and more, while tactile and deep muscular senses seemed very little disturbed. Just above the level of the nipple, a little higher on the left side, there was a well-defined band three to four inches wide extending around the body which was distinctly hyperesthetic. From this level down the sensation was disturbed as just described. The thoracic and abdominal organs and the cranial nerves were all normal, and the arms showed no sensory disturbance or paralysis. The weakness of the legs increased daily. On September 10 and 13 lumbar punctures were made, but no fluid obtained. On September 23 a third lumbar puncture yielded about 20 c.c. of light colored amber fluid, which came out slowly, drop by drop, under low pressure. This fluid showed a marked positive Noguchi reaction and contained very few cells, mostly lymphocytes. During this time his temperature, pulse and respiration were normal. Urine normal. Wassermann's reaction of the blood negative. No tuberculin reaction. Blood: WBC, 8,000 (polynuclears,

Digitized by Google

63 per cent., lymphocytes, 33 per cent., eosinphiles, 2 per cent., basophiles none); RBC, 5,120,000; hemoglobin, 87 per cent.

With the above symptoms, we inferred that the patient was injured at the time of the scrimmage in football, that owing to this injury, there was a subdural hemorrhage in the upper dorsal region of the cord and perhaps some laceration of the meninges, possibly a fracture of one of the vertebræ, although a radiograph of the spine showed no abnormality. It seemed likely that at the time of the injury there was not sufficient pressure on the spinal cord to cause any decided cord symptoms but that a lesion gradually developed which in some way compressed the cord and slowly increased the symptoms. Operation was advised and the patient was sent to the first surgical division on October 27. During the month of October the weakness increased so that the patient was wholly unable to walk. The operation was done October 28 by Dr. Blake. An incision from the seventh cervical to the fourth dorsal vertebra was made. Considerable bleeding was met with superficially. No evidence of a fracture or dislocation in the vertebræ could be found. The dura, when exposed, showed a little old fibrinous exudate. The exposed dura seemed to be very tense and distended. In color it was rather dark and no pulsation was felt at this point. On being opened, the dura was at once expanded bilaterally by a tumor mass which resembled a large blood clot and which surrounded the cord from the seventh cervical to the third dorsal vertebra about 7.5 cm. and showed the consistence of a granuloma. The cord at this point was very much compressed so that it seemed smaller in diameter than above or below but its continuity still existed. The tumor mass was removed piecemeal by a spoon and forceps, care being taken to preserve the cord. After as much as possible of this material was removed, the dura was sutured over the cord with fine catgut and the layer of muscle and skin united with interrupted silk worm gut sutures. The operation occupied one hour and five minutes. The patient made a fair recovery from the anesthetic. Almost immediately after recovering consciousness the patient could move his legs much better than before the operation. The temperature after operation rose on the second day to 102° but immediately fell to normal after the removal of a large bloody exudate which had collected beneath the skin at the point of operation. Catheterization was necessary on the night of operation but not afterwards. November 10—the temperature has remained normal. The patient's condition has steadily improved. He draws up his legs almost to full flexion, which it was quite impossible for him to do before the operation. The pain and temperature senses have improved so much that they are nearly normal. The ankle clonus, patellar clonus and Babinski reaction still continue. The patient has been seated in a chair. November 28—the improvement continues. The wound is entirely healed. The patient has been up and walks about with a chair. The patellar clonus and ankle clonus are much diminished, the patient is gaining complete control over his legs. December 22—the patient left the hospital to-day, walks very well without assistance or without guiding himself with a chair or cane. Sensory

Digitized by Google

disturbance has disappeared. A slight ankle clonus still exists in the right leg. The Babinski reaction is slightly present on both sides. The patient has experienced no more pain between the shoulders. He returned to his home in the South. The report received in June, 1910, states that he is now able to walk several miles daily through the woods and is able to play tennis, in fact that he feels almost as well as ever. In October he was still in excellent condition.

The tumor tissue in the gross appeared like an old blood clot. Microscopically it consisted of endothelial cells arranged in layers around the blood vessels and lying in a mesh work of fine fibrils. In some places the cells present a regular star-like radiation outward from a blood vessel. This picture is very much like that of a neuro-epithelioma, in which the glia cells and fiber striations around the blood vessels form stars. In other places the arrangement of the cells appears more like that in a hemangio-endothelioma of the dura. "Throughout the tumor tissue can be seen here and there fresh hemorrhages and the remains of old hemorrhages, the tumor is, without a doubt an endothelioma of the perithelial type" (see illustration).

Summary.—The case is of interest, first as an example of a tumor developing immediately after injury, and, secondly, for the brilliant results of the operation. It is very likely that the patient at the time of the injury had a subdural hemorrhage and possibly some laceration of the meninges. As a result of this injury to the tissue, the formative or recreative activity of the low type endothelial cells was awakened with the development of a neoplasm. Another interesting feature is the peculiar dissociation of sensations which was present in the case. The patient was at all times capable of recognizing a touch as well as the position of his legs, feet and toes. In other words, he had no tactile or deep muscular sense disturbance. He had, however, a marked disturbance of the pain and temperature senses, and in addition, before the operation nearly complete paralysis of both legs. The paralysis was spastic and was due to a compression and interference with the function of the central motor neurones at the level of the tumor. The question naturally arises, why did the patient have loss of pain and temperature sense and while his tactile and deep muscular

Digitized by Google

Microphotograph of an extramedullary perithelial endothelioma of the cord.

Digitized by Google

Digitized by Google

senses were practically normal. The tumor surrounded the cord and compressed it equally from all sides and therefore involved or interfered with the function of those systems lying peripherally in the cord but did not so much interfere with the function of the systems lying deeper in the cord tissue. There seems to be no doubt that pain and temperature senses pass up Gowers' tract after having crossed through the anterior commissure, and as Gowers' tract lies very superficially it was naturally affected by the surrounding tumor. On the other hand the tactile and deep muscular sense fibers passing up the cord in the posterior columns and being situated more deeply or further away from the periphery of the cord were not involved as were the pain and temperature sense fibers. This, therefore, would account for the disturbance in the pain and temperature senses and for the normal condition of the deep muscular and tactile senses. It is also possible that the tactile and deep muscular sense fibers, aside from being situated rather centrally in the spinal cord, are less vulnerable to pressure than the more peripherally situated fibers of the pain and temperature senses.

The patient was under the care of the Second Medical and First Surgical Divisions of the Presbyterian Hospital, and our thanks are due to Dr. Kinnicutt and Dr. Blake for the privilege of using the records of their observations.

Digitized by Google

Digitized by Google

XXX.

A NEURO-EPITHELIOMA DEVELOPING FROM A CENTRAL GLIOSIS, AFTER AN OPERATION ON THE SPINAL CORD.*

By M. G. Schlapp, M. D., Lately Neurologist to Out Patient Department.

Syringomyelia is a pathological condition about which much has been written and many different opinions have been expressed as to the nature and etiology of the lesion.

The Leyden-Virchow hypothesis considers all syringomyelias the result of a disturbed condition in the development of the spinal cord.

Secondly, we have the theory that syringomelia is the result of necrotic changes in newly formed glia tissue of a neoplastic nature. This idea has been advanced and supported by Simon, Schultze, Westphal, and others.

Another idea advanced by Hoffmann considers the tumor formation the final result of developmental anomalies, which tumor tissue might in time undergo necrotic changes, thereby giving rise to the cavities. Hoffmann says: "Die Grundlage und der Ausgangsspunkt des Krankheitsprocesses bilden in der Mehrzahl der Fälle congenitale Entwickelungsanomalien, welche sich in dem Zuruckbleiben von Nestern embryonalen Zellen desselben aussern. Mehrfache Anlage des Centralcanals hat eine ähnliche Bedeutung."

Still another idea is the one of Hallopeau, later accepted by Charcot, Joffroy-Achard, Critzmann, Raymond, Phillippe-

(*Reprinted from The Journal of Nervous and Mental Disease, March,* 1911.)

Digitized by Google

Oberthur, and others, which considers syringomyelia the result of a chronic inflammation with subsequent necrosis and cavity formation.

Schlesinger, Saxer and several others have taken a broader view of the etiology of syringomyelia. Schlesinger says: "Die ausfuhrliche Besprechung der verschiedenen Hypothesen über die Entstehung der Syringomyelia hat gezeigt, wie wenig sicheres und gut begrundetes Material für Entscheidung der einzelnen Fragen vorhanden ist. Gesichert durft die auch schon früher von mir vertretene Annahme sein, dass die anatomische Aetiologie der Syringomyelia nicht einheitlich ist."

To consider the literature of syringomyelia would take me beyond the scope of this paper, and up to the period of 1901 it was carefully considered by Schlesinger in his monograph, "Die Syringomyelie."

The following case is interesting on account of the atypical group of symptoms presented, and even more interesting on account of the pathological findings.

The patient had been under observation in the Presbyterian Hospital Clinic for nervous diseases for over a year before being sent into the hospital for surgical interference. P. H., male, age 43; carpenter, born in Scotland.

Family History.—Father 82 years old, living and well. Mother died of Bright's disease at the age of 75. One brother and four sisters, living and well. No history of any nervous or mental disease, no rheumatism, gout, tuberculosis, cardiac or malignant disease in family; no deformities. Patient has been in the United States seventeen years, and worked at his trade as a carpenter up to one year ago. He is married, has four healthy children; his wife has never had a miscarriage. His habits were good, never used alcohol or tobacco; never had a venereal disease. When a child had scarlet fever, measles and whooping cough from which recovery was complete. From childhood to about ten years ago always enjoyed good health and was very active. About ten years ago he noticed that he had at times some difficulty in starting the flow of urine. At that time he did not pay any special attention to this condition. One year later (about nine years ago) there was a sudden onset of severe pain in the lumbar region of the spine with a girdle pain around the abdomen. A week later weakness and numbness developed in both legs, although not complete paralysis. Any jarring of the body at this time, or for some time later,

Digitized by Google

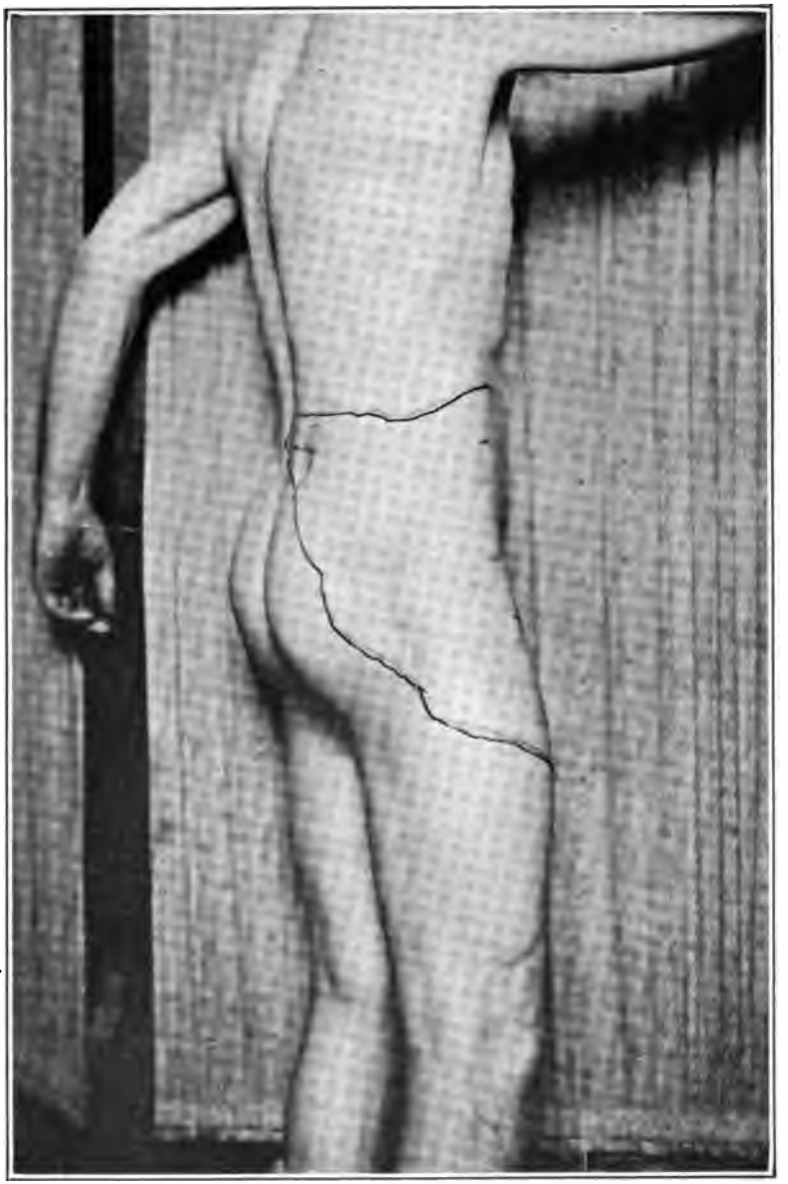


FIG. 1.—Photograph of body, the anterior view and posterior view showing the area of anesthesia. On the front view there is an area marked "2" where the tactile sense is entirely lost but pain sense and temperature sense partly preserved.

Digitized by Google

FIG. 1a.—Photograph of body, the anterior view and posterior view showing the area of anesthesia. On the front view there is an area marked "2" where the tactile sense is entirely lost but pain sense and temperature sense partly preserved.

Digitized by Google

such as laughing, coughing or riding on a street car, would intensify the pains and cause rigidity of the muscles of the legs. The left leg recovered in a few weeks, but the patient was incapacitated for work for three months by the pains and partial loss of power in right leg. After three months he resumed his usual work, but was obliged to use his right leg with special care, as any jar to it would cause intense pain, and on several occasions this pain caused him to fall to the ground. Four years after this first attack he was again incapacitated for work by an acute attack of pain in the lumbar region and in the legs. This, however, lasted only four days. About eighteen months ago, or about five months before he came to the clinic, he had another attack of pain in the lumbar region and in the right leg, with partial loss of power of the right leg. Since this attack he has not been able to return to work because of the pain and weakness in this leg.

The retardation of urination has increased somewhat, several minutes often elapsing before the urine will flow. For several years there has been slight loss of rectal control, but not severe enough to cause inconvenience. Sexual vigor has been impaired somewhat, but not lost. There have been no pulmonary or gastro-intestinal symptoms. Patient has not lost weight. Appetite is good. Bowels are regular. The chief complaints are weakness and partial loss of control of right leg, pain in lumbar region and in right leg. Paresthesias over abdomen, especially over right side. Anesthesia of anterior portion of upper right leg; slight loss of control of sphincters.

Status.—Patient is a well nourished man, slightly anemic; no scars on body; skin clear; lymph glands not enlarged. Tongue: moist and clean; teeth in fair condition. Eyes: pupils equal, react to light and accommodation; extrinsic ocular muscles normal; visual field normal. Ears: normal. Taste and smell: normal. Heart: apex impulse not visible or palpable; dulness extends three inches to left of mid-line; no enlargement to the right; action regular; no murmurs. Pulse rather weak but regular; vessel walls not palpable. Lungs: slight dulness at both apices; no signs of distinct lesions. Liver: negative. Spleen: negative. Abdomen: symmetrical; moves easily with respiration; no rigidity.

Extremities: Upper extremities normal; lower extremities appear normal in size; no atrophies. A slight tremor of the quadriceps of the right leg is noticeable, which is intensified after the muscle has been contracted and relaxed, or when the muscle is percussed. Right leg is decidedly weaker than the left, but is not paralyzed; slight ataxia of the right leg, none of the left. Knee jerk exaggerated, more so in the right leg than in the left. Patellar clonus present on right side. Ankle clonus present constantly on right side; at times present on the left, though usually absent. Babinski reflex present constantly on right side; on left varying as does the ankle clonus, sometimes distinctly present, sometimes absent. Plantar reflexes are exaggerated on both sides. Cremasteric reflex absent on right side, present but diminished on left side. Abdominal reflex absent on right side; present, but dimin-

Digitized by Google

ished, on left. Paresthesias are felt in both legs, varying in intensity from time to time. No sensory disturbance on left side of body, but on the right there is an area of complete anesthesia. The area of loss of pain and thermal senses does not extend down onto the anterior surface of the leg so far as does the loss of tactile sense. The lower boundary of the area of loss of pain and thermal senses is represented by the line No. 1. The lower boundary of loss of tactile sense is represented by line No. 2 on the accompanying photograph. Over this area on which there is found anesthesia, patient at one time felt a burning sensation, and even up to the time of the operation he felt this same sensation, although to a less degree. The accompanying photographs show the area of anesthesia so well that a verbal description is unnecessary.

My interpretation of the symptoms presented was as follows: 1. The pain in the legs, especially in the right one, and in the lumbar region I took to be the result of an irritative lesion involving the posterior roots in the lumbar region. After some years there appeared in addition to these root symptoms what seemed to me to be pressure symptoms of the cord. Some time after the irritative root symptoms had existed they changed into paralytic symptoms, definitely involving the first, second, third and fourth posterior lumbar roots, namely, anesthesia in areas supplied by these roots. The pressure symptoms of the cord increased, indicated by weakness of right leg, increase in tendon reflexes, Babinski, etc. The absence of the cremasteric and abdominal reflexes on the right side I considered due to destruction of the sensory half of the reflex arc in the lumbar region. Considering all symptoms carefully, having observed the patient for fourteen months, since August, 1904, I concluded that they were caused by an extramedullar tumor growing along the right side of the cord, involving the first, second, third and fourth posterior lumbar roots and compressing the cord. I advised an operation for the removal of the tumor, which, on account of its very slow growth, I thought to be a fibroma. The operation was performed by the late Dr. A. McCosh, who very kindly allowed me to use his bedside notes.

October 28, 3 P. M.: Ethyl chloride and ether well taken. Incision four inches on median line exposing tenth, eleventh, twelfth dorsal and first lumbar spinous processes. Spines exposed and twelfth and eleventh dorsal spines removed with bone-cutting forceps, posterior arch removed with considerable hemorrhage resulting, which was controlled by packing. The dura was plainly exposed. No tumor was seen or felt even above and below exposed dura. Dura was opened and cord exposed, but no tumor could be found. Tenth dorsal spine and arch removed as above; no tumor found, but adhesions on the right side of cord between the pia and dura were found and separated with the finger. Dura was closed with a continuous fine plain gut; muscles pulled together with plain gut, deep silk interrupted sutures for muscles and skin. Skin was also closed with continuous plain gut. One cigarette drain. Time of operation one hour and five minutes. Condition good. Following the operation patient was in a condition of extreme shock, pulse for twenty-four hours being

Digitized by Google

FIG. 2.—Trans-section of the spinal cord at a level of the fourth cervical showing the central gliosis with cavity formation and a gliosis extending to the periphery along the posterior septum. There is also some gliosis seen throughout the white tissue of the cord, especially in the lateral columns.

Digitized by Google

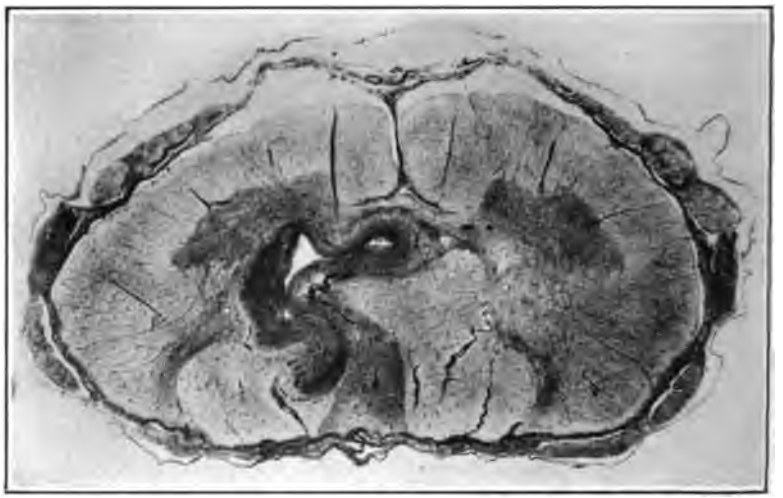


FIG. 3.—Trans-section of the cord, eighth cervical segment showing the gliosis with cavity formation, also gliosis extending along the posterior fissure and a gliosis in the white matter throughout the cord.

Digitized by Google

between 150 and 160 per minute, at times imperceptible. Bloody oozing from wound very profuse. Had very much pain in connection with spasms of abdominal muscles. Cannot void urine, is completely paralyzed from waist down. Reflexes of lower extremities absent. Has been vomiting almost continuously, abdomen distended. Temperature 101 degrees.

October 29. Condition this morning improved; temperature fallen to 96.9 degrees; pulse 128. Sensation in right side completely lost up to unbilical line, indistinct sensation felt in left leg. No motion below waist line. No control over bladder or bowels. Abdomen slightly distended.

November 4. General condition since last night decidedly improved. Temperature is approaching normal. There is very little abdominal distension. Appetite is improving. Has no sensation in right lower extremity, indistinct sensation in left leg. There is tactile sensation over lower part of abdomen on right side where there was none before the operation. Control over the sphincters lost. There are blisters on heels and buttocks, with induration of the left buttock.

November 7. General condition remains about the same. Temperature 99.5; pulse 80; respiration 24. Appetite good. Pain no longer felt in back. All voluntary motions lost below the waist. No knee jerks or any other reflexes present in legs. No sphincteric control. Sensation absent in right leg; much diminished on left leg since last examination. Bed sores present on each buttock and each heel.

November 12. Temperature, pulse and respiration normal. General condition has improved. Bowels move with cathartics. No sphincteric control. No return of motion or sensation; sensation lost on left leg.

November 17. For the last three days patient's temperature has been rising to 101-102.5 degrees; since yesterday the pulse has been over 100. Lungs and abdomen negative. No return of sensation or motion. No sphincteric control. No reflexes. Sloughing bed sores over sacrum and buttock.

November 21. The bed sores are spreading, one over the coccyx reaches the bone and has a pocket extending toward the rectum, discharges much pus. The surrounding skin is very much reddened and a marked induration is present. Rectal examination reveals no induration in the ischiorectal fossa. The temperature fluctuates from normal to 103 degrees; the morning decrease has been less for yesterday and to-day.

November 23. Patient had a chill last night with nausea. Temperature rose to 105.4; lungs negative.

December 3. Since the last note patient's condition has been growing gradually worse; he is weaker and more emaciated. Complete anesthesia below the umbilicus; complete paralysis of the legs and of the sphincters. No reflexes present. Temperature is of a septic type, reaching 103 at night. No opisthotonus present. Lungs and abdomen negative. The undermining of tissue from bed sores is very extensive; a probe can be passed from the sacrum to the great trochanter under the superficial tissue.

Digitized by Google

December 8. Patient had a chill this morning; temperature going to 104.4; pulse 140; respiration 26. Complains of loss of hearing accompanied with a roaring sound in ears, pain in back of neck. Complete paralysis and anesthesia as above. Very emaciated. Lungs negative. Abdomen moderately distended, no tenderness or rigidity.

December 10. Three chills yesterday, one to-day. Gradual failure of circulation; exitus.

Autopsy.—December 10, 1905, five hours after death by Dr. Tuttle. Dr. Thatcher has kindly permitted me to use the hospital report made by Dr. Tuttle.

Frame medium; adipose scant; muscles atrophied. Surface: bed-sores over sacrum, scar of laminectomy wound over dorsal vertebræ. Diaphragm, right side, fourth rib; left side, fifth rib. Heart normal. Lungs: left, 10.6 oz.; pleura normal; section shows some emphysema, otherwise normal. Right, 11 oz.; pleura shows some adhesion over upper lobe; section same as left. Peritoneum normal. Gall-bladder contains few drops of yellowish bile. Liver: 82 oz.; consistence soft, surface smooth, section appears normal. Pancreas: 4 oz.; normal. Kidneys: left, 9.5 oz.; ureter double, both tubes considerably dilated; capsule free; surface smooth, one side pale, other normal in color; section shows pelvis normal, cortex comparatively thin, in places pale, markings irregular. Right, 5.5 oz.; double ureter as in case of left. Adrenals normal. Stomach normal. Bladder: contains moderate amount of urine with some mucus and pus, mucous membrane appears normal. Brain: considerable amount of pus is seen between the dura and pia extending up the sides and over the convexities of the hemispheres. The pia is yellowish in color with opaque yellowish exudate along sulci. Brain and cord not examined; placed in ten per cent. formalin solution. Tissues of lower part of back above bed-sores are edematous. There is a small abscess containing a foul smelling pus close to the dura of the cord at the seat of the operation. The spinous processes of the tenth, eleventh and

Digitized by Google

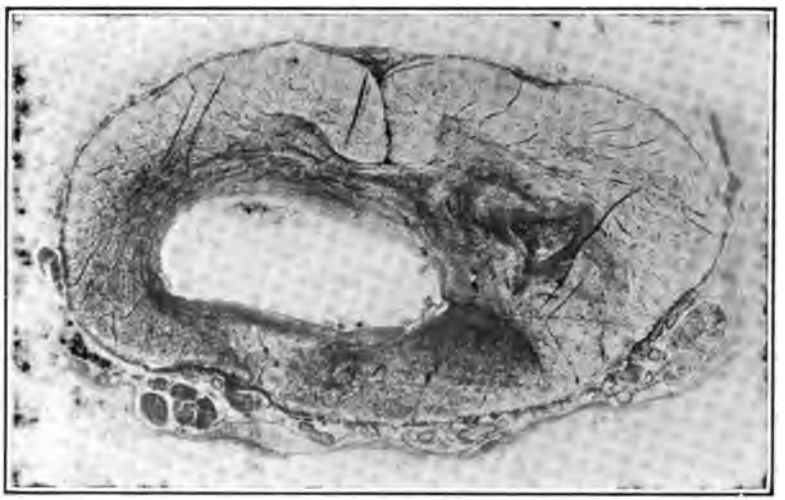


FIG. 4.—Trans-section of the spinal cord at a level of about the seventh dorsal. A gliomatosis in the left and right posterior horns with two-cavity formation.

Digitized by Google

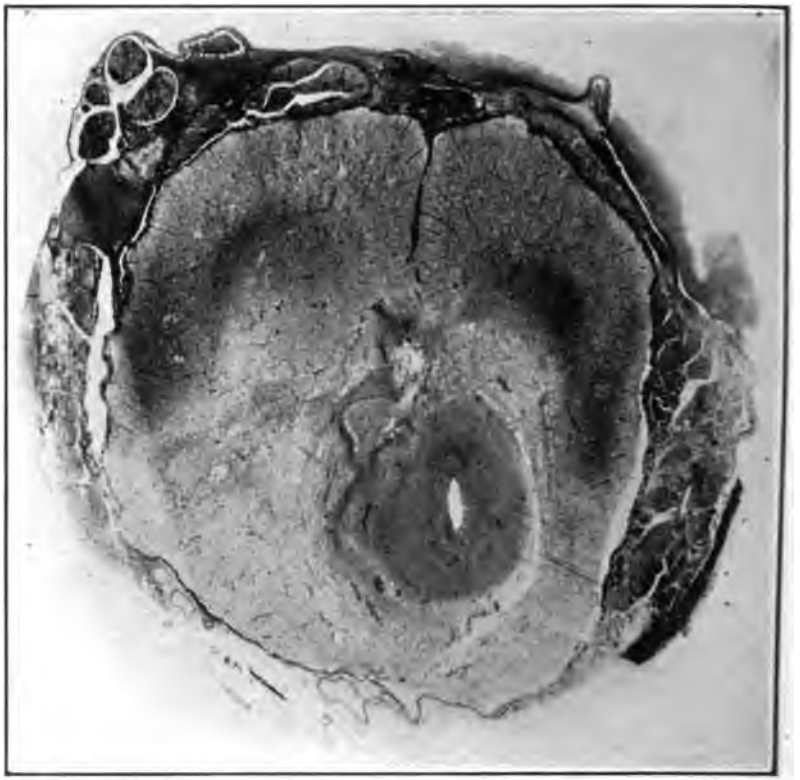


FIG. 5.—Trans-section of the spinal cord about the third lumbar segment showing a distinct gliomatosis involving the right posterior horn and the right posterior root zones, cavity formation in the center. This lesion accounted for the area of anesthesia on the body.

Digitized by Google

twelfth dorsal and first lumbar vertebræ are absent. At the lower end of the scar the dura is of a slaty color, and under this region a great deal of pus is found.

Microscopical Appearance.—After the cord had been hardened, sections were made through it at intervals of about one centimeter. This revealed an unexpected condition. From the upper cervical segments throughout the cord a central gliosis and syringomyelia occupied the extent and location in different segments of the cord as follows: It was found that in the upper cervical segments the gliosis did not spread very far laterally into the gray matter, but seemed to have started from a point lying posterior to the central canal, and developed from here along the posterior septum to the posterior periphery of the cord, the band of glia tissue being about .5 mm. wide on each side of the septum. At about the fifth cervical segment another mass of compact glia tissue appeared, lying along the medial border of the left posterior horn, to some extent involving the horn, and extending to the periphery of the cord. In this mass of glia tissue a cavity began to form at about the sixth cervical segment; this cavity increased in size toward the dorsal segments of the cord; in the lower dorsal segments it was distended with blood. At about the fifth dorsal segment a third compact mass of glia tissue appeared in the right intermediate gray matter, and extended posteriorly into the right posterior horn. In this mass another cavity is seen, which also increases in size downward, but does not equal the size of the cavity on the left side. At the tenth dorsal segment a mass is appearing which seems to have destroyed the whole cord excepting a very small border of cord tissue surrounding it. Even the glioses seem to have been destroyed by this mass. This mass is a tumor which extends through the eleventh and twelfth dorsal, first and second lumbar segments, tapering off

Digitized by Google

at the upper and lower ends. The glioses appear again at the lower end of this tumor, but seem to have moved to the right of the cord and united to form two round masses lying in the right posterior column, diminishing rapidly in size as they descend, forming one mass. At the third and fourth lumbar segments the round mass of glia tissue lies in the right posterior and middle root zones. Below these segments it passes out of the posterior columns and is situated around the central canal, which position it keeps to the end of the filum terminale. In the medulla, pons and crura no pathological condition is seen.

Microscopical Examination.—There is a well-marked polynuclear cell infiltration in the meninges and around the blood vessels entering the cord tissue, due to the secondary purulent meningitis. Nowhere in the cord is there any evidence of the presence of the central canal or its lining ependyma cells. The gliosis throughout the cord is situated in the posterior portion, and does not spread ventrally beyond the anterior commissure. In the cervical cord there are two masses of proliferating glia tissue, which, however, seem to be connected in the gray commissure. The one, the denser of the two, lies along the medial border of and takes in some of the left posterior horn. In the middle of this mass there is distinctly seen necrotic dissolution of the tissue with subsequent cavity formation. In the other mass of glia tissue which extends along the posterior septum to the dorsal surface of the cord, the necrosis has not taken place, and throughout this gliosis many of the axis cylinders of the nerve fibres around which the glia tissue has proliferated are visible. From both of these masses the glia is gradually invading the surrounding nerve tissue. Throughout all the white matter in different regions there is seen distinctly a marked increase in the glia tissue, so that there is not only a

Digitized by Google

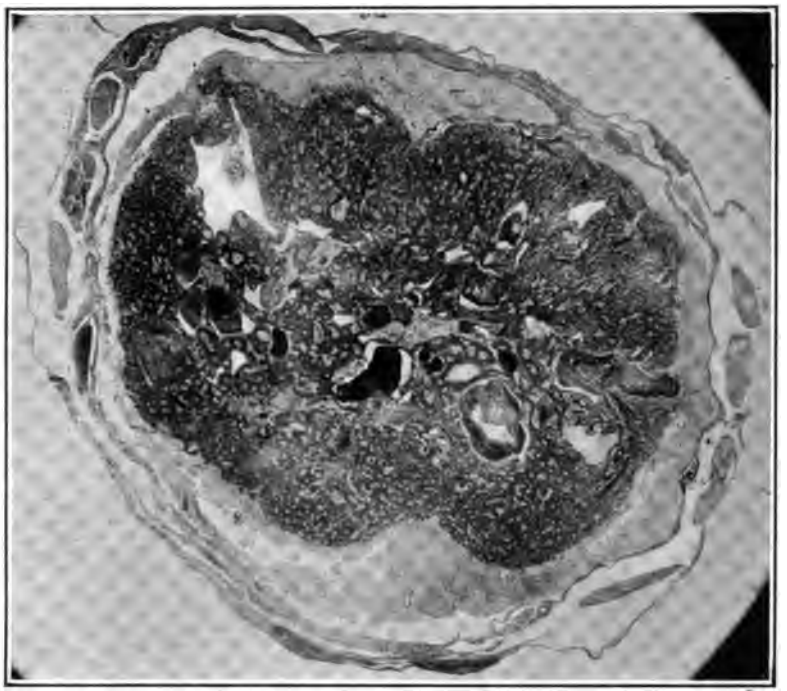


FIG. 6.—Trans-section of the cord in the twelfth dorsal showing destruction of the spinal cord by a tumor mass, neuroepithelioma, a very thin mass of spinal cord tissue lying round the tumor. The cysts are well represented, some of them filled with a colloid substance and necrotic tissue. The smaller light areas are the light zones around the blood vessels.

Digitized by Google

FIG. 7.—High power photograph showing a blood vessel and light zone around the same with the radiating gliosis fibrils extending to the perivascular lymph space.

Digitized by Google

proliferation of glia tissue in or about the distinct mass, but there is unquestionably a general increase of glia tissue throughout the whole of the cord. This increase appears to be especially marked around the blood vessels. The perivascular lymph spaces seem to be occluded, partly by the increase in connective tissue of the adventitia of the blood vessels, and partly by the increase of the glia tissue surrounding the perivascular lymph space. In the glia tissue outside of the large compact masses of glioses there are no more glia cells than in a normal spinal cord, although the glia fibers are much increased in quantity. The glia cells in the compact masses of glioses are slightly increased in numbers, but not to a marked degree. The gliosis along the posterior column does not differ apparently from the gliosis found in cases of multiple sclerosis, or in areas where there has been primary lesion of the nerve tissue with secondary gliosis. Descending from the cervical cord into the dorsal region one can see a gliosis forming in the right posterior horn in addition to the masses in the left posterior horn and along the posterior septum. In this gliosis of the right horn a cavity is forming as in the left, although nowhere throughout the cord does the gliosis in the right horn develop to the size of the gliosis in the left horn. In the lower part of the dorsal cord, or from the fourth dorsal segment downward, hemorrhage and softening are present, increasing at lower levels. At the eleventh dorsal segment the tumor (a neuro-epithelioma) is beginning to appear in the right posterior quadrant of the cord, increasing in size downward and reaching its largest diameter at about the first lumbar and decreasing in size downward from this point to about the second lumbar segment, where the tumor ends. Below the tumor the glia masses again appear, but they have changed their position and appearance. The gliosis which in the cervical

Digitized by Google

dorsal segments of the cord was situated in the right posterior horn has become more compact, shaping itself into an oblong mass whose longest diameter is four millimeters and whose shortest diameter is three millimeters, and has moved from the posterior horn into the posterior and middle root zones. The gliosis which in the cervical and dorsal region was situated along the posterior septum, has moved into the right posterior column, and has also developed into a very compact mass of glia tissue. Both these gliomatoses have a small cavity in their center. These two bodies of glia tissue are situated in the right posterior column compressing the right posterior and middle root zones, displacing the right posterior horn to the right and the posterior septum to the left. The gliosis of the left posterior horn is not present here. Throughout all the lower dorsal, lumbar and sacral segments of the cord there is a very marked necrosis of the tissue with more or less hemorrhage.

The tumor, as the accompanying photograph shows, has practically destroyed the whole cord from the twelfth dorsal to the second lumbar segment. It consists of glia cells with glia fibers, in which tissue are seen many large and small cavities lined with ependyma cells. In these cavities there are found broken down nerve tissue, blood, fibrinous exudate, etc. Throughout the tumor tissue there are many blood vessels, around which there is seen a zone of tissue containing no nuclei of tumor cells, but made up principally of radiating glia fibers which pass from the surrounding glia cells to the connective tissue lining of the perivascular space, where the glia fibers attach themselves to this connective tissue.

The cavities lined with ependyma cells and found throughout the tumor are positively not diverticulæ of the central canal of the cord, since these ependyma cells originate from the tumor cells. In certain portions of the growth this ependyma cell

Digitized by Google

lining is not found as a lining of a cavity, but is seen on the outskirts of the tumor as if protecting the tumor cells from the necrotic tissue beyond. In fact it seems that wherever we find this ependyma lining, it is growing around a mass of fibrinous coagulum and blood or necrotic tissue. On the other hand, wherever we find such a mass of fibrinous coagulum and blood we always find either this ependyma lining just beginning to form around the coagulum or entirely surrounding it.

The glia cells of the tumor, when forming an ependyma lining, crowd together irregularly at first, but later in the course of the development of this ependyma formation the nuclei are seen arranging themselves regularly in a row. In some parts of the tumor, especially along its periphery, one can see clearly this ependyma formation developing around necrotic tissue. In the early stages of development of this ependyma formation the nuclei resemble those of the tumor cells; in the later stages, where this formation is well developed, the nuclei become elongated, the long axis being usually at right angles to the surface of the cavity, and the nuclei stain more intensely with hematoxylin and are smaller in size.

That part of the glia cell body which lies toward the cavity from the nucleus seems to fuse with the neighboring cells to form a homogeneous layer of tissue between the cavity and nucleus. With a high power lens there is seen very faintly what seems to be a line separating two adjoining cells. Here and there are seen protruding into the cavity from the cell very fine filaments which are no doubt cilia. That part of the cell body lying on the tumor side of the nucleus, instead of presenting the homogeneous appearance the other half of the cell body does, which lies on the cavity side of the nucleus, is clearly seen to break up into glia fibers radiating into the surrounding tumor tissue, just as do the glia cells of the tumor.

Digitized by Google

There are a number of interesting facts presented by this case, some of which deserve an effort at interpretation.

First, it is of importance to note the amount of gliosis that existed in the cervical and dorsal segments of this cord, without producing any symptoms that could have been ascribed to a lesion in these segments.

Secondly, it is of interest to see how a central gliosis developing into a gliomatosis, can extend into the white matter of the cord and produce symptoms quite unlike those which we recognize as classical for central gliosis. In this case the gliomatosis extended into the right posterior column, destroying the root zones and the right posterior root fibers of the first, second, third and fourth and partly of the fifth lumbar segments, giving a clinical picture of a well-defined area of anesthesia on the right side of the body, as shown by the photograph. The pressure on both crossed pyramidal tracts, especially on the right one, produced by this gliomatosis, accounted for the symptoms found in both legs. The absence of the cremasteric and abdominal reflexes on the right side was due to the destruction of the centripetal half of this reflex arc by the gliomatosis in the segments in which it was found.

Thirdly, and the most interesting feature in the case, is the tumor, which was found destroying the whole of the cord from the tenth dorsal to the second lumbar segments.

The clinical symptoms will not allow us to accept the view that the tumor was present in the cord at the time of the operation. All the symptoms present before the operation can be explained by the presence of the gliomatosis alone. This tumor, therefore, must have developed after, and, as I shall endeavor to show, probably in consequence of the operation.

In the literature on the cases of neuro-epithelioma of the cord I find that all of the authentic and well-examined cases,

Digitized by Google

with the exception of one or two, are accompanied by a central gliosis. In these exceptions the tumor had destroyed so much of the cord that it would be impossible to say whether there was or was not an underlying gliosis present. It seems, therefore, that a central gliosis is a condition almost constantly found in cases of neuro-epithelioma.

The histological picture of a gliosis, whether it be a progressive or a replacement gliosis, is not that of a true neoplasm. We find that the cells are very slightly increased in numbers, in some instances apparently not at all increased, while the glia fibers represent the bulk of the new tissue.

If we accept the theory that the formation of the glia fibers is due to the functionation of the glia cell, a katabiotic process, we can logically go a step further and say that this gliosis is brought about by an external stimulus to the glia cell, as all functional activity is awakened by an external stimulus.

That this functional activity of the glia cell is more easily awakened in one individual than in another cannot be doubted. For example, a child develops a focal encephalitis as the result of an attack of measles, scarlet fever or some such infectious disease. During the acute stage of the encephalitis and for several weeks or months after this period the child will have convulsions, general or Jacksonian in character, but at the end of this period the convulsion will cease. It now seems that the child has entirely recovered from the effects of the encephalitis; but after the expiration of a year, more or less, the convulsions again appear, increasing in intensity and frequency, and in addition, the child develops a progressive idiocy. The microscopic examination reveals a widely distributed gliosis of the cortex, which undoubtedly developed from the focal encephalitic lesion. Another child, having the same encephalitis with convulsions during the acute stage and perhaps for some time

Digitized by Google

after, will lose them permanently, no progressive gliosis having developed from the focal encephalitis. As another example: one patient will develop a central gliosis as the result of a hemorrhage or lesion whereas another will not develop a central gliosis.

This susceptibility of the glia cells to stimuli in awakening their functional activity, not only varies in different individuals, but we find it varying in different glia cells of the same individual. The glia cells around the central canal of the spinal cord, especially those lying posteriorly to the central canal, seem to require less stimulation to awaken their functional activity than the glia cells lying some distance from the canal, or some distance from the embryonic cavities of the central nervous system.

The view that these central glia cells have retained to a certain extent their embryonic characteristics, has been expressed by Hoffmann and others, but the fact of their retaining these embryonic characteristics is in itself not sufficient to account for the awakening of the functional activity of these cells. There must be an external stimulus of some kind brought to bear upon the cells in order to awaken this activity. This stimulus in one case might be a hemorrhage, or even a slighter temporary disturbance of the blood or lymph circulation, a laceration of the tissue as the result of a trauma, or it might be a localized inflammation, etc.

The key to the whole question, therefore, seems to be: What is the underlying cause for the difference in the susceptibility of the glia cells to stimuli in awakening their functional activity in two individuals; why are glia cells more unstable in one case than in another? In order to present this whole matter a little more clearly, let me briefly consider the life processes in a living cell.

Digitized by Google

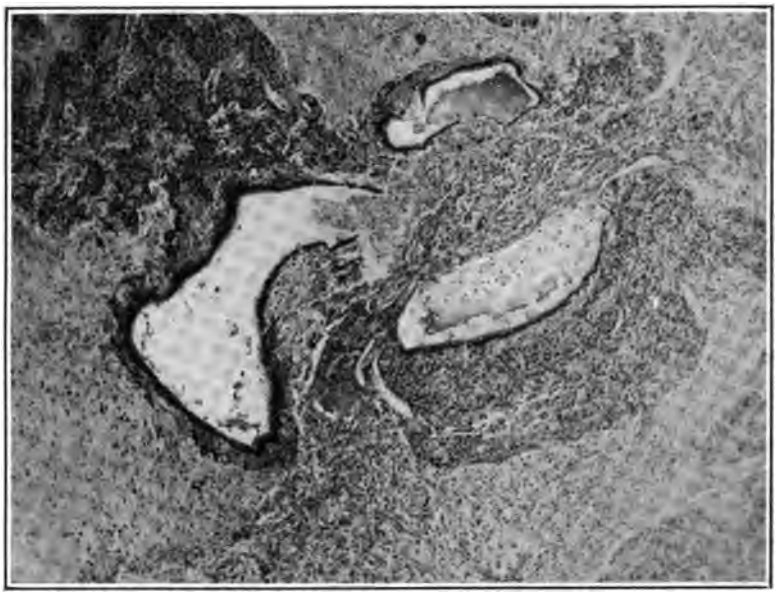


FIG. 8.—Illustration of three well-defined cysts partly lined with ependyma cells and some parts of this cyst wall the gliosis cells are arranging themselves to form the characteristic ependyma lining.

Digitized by Google

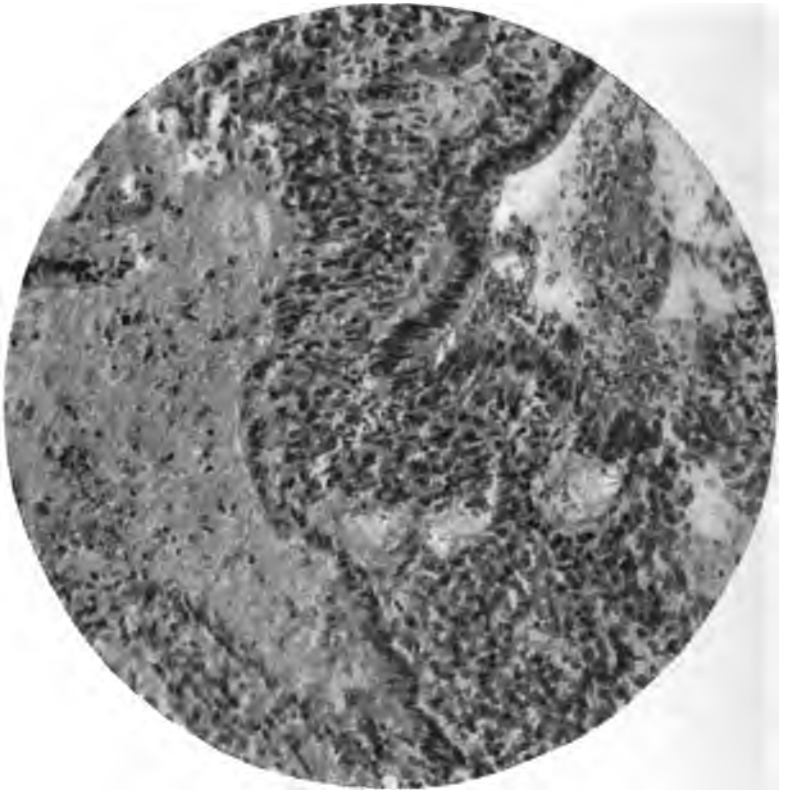


FIG. 9.—High power photograph showing a cyst wall with the ependyma lining formed at one part and beyond the glia cells arranging themselves in a row preparatory to forming the characteristic ependyma lining. It seems that this formation of the ependyma lining usually takes place around necrotic tissue.

Digitized by Google

There are three such processes: (*a*) Nutritive activity, (*b*) formative activity, (*c*) functional activity.

The nutritive activity is that process whereby a cell is capable of taking up from the surrounding medium material which it stores up in the nucleus and cell body as potential energy for the purpose of carrying on these life processes. The formative activity is that process whereby a cell is capable of dividing into two or more daughter cells. The cell begins to divide when the limit of capacity of the cell is reached. That is, if the nutritive activity is causing the cell to continuously take into its body material which is not being used by the functional activity, the limit of capacity of that particular cell will be reached and cell division will take place.

The functional activity is that process whereby a cell is capable of doing some act, such as the contraction of a muscle cell, the secretion of a gland cell, the transmission and production of nerve energy, the secretion or excretion of glia and connective tissue fibrils from their respective cells. In carrying out these acts, material and energy are necessary and the cell draws on the supply furnished by the nutritive activity.

The next question is: How are these different processes awakened from the dormant into the active state?

First.—The functional activity can only be awakened by some external stimulus. Thus, by light waves, electrical waves, heat, mechanical and chemical stimulations, nerve impulse, etc. All these stimulations must, however, have a definite value before they can awaken the functional activity; if they fall below this value or strength, they fail to awaken the functional activity; the point at which such an external stimulus just causes a reaction is called the "threshold of functional activity." The threshold of functional activity can be raised or lowered. This is done electively by certain substances affecting

Digitized by Google

certain groups of cells. Thus it is a well-known fact that strychnine injected into animals lowers the threshold of functional activity of the motor cells in the spinal cord, causing them to react to a much slighter stimulus than under normal conditions. Morphine raises the threshold of functional activity of the sensory cells in the cortex, etc.

This threshold of functional activity in the different cells of the body must under normal conditions be regulated by substances produced within the body itself. To give a striking example: It has been shown (Starling) that the fetus of a pregnant female produces substances, hormones, which either lower the threshold of functional activity of the mammary glands, or stimulate the nutritive activity of these cells, or both, thereby awakening both the functional and formative activity, but holding these activities within bounds.

If by an external stimulus a cell is made to functionate, changes of a katabolic nature will take place in the cell, which changes will in turn stimulate the nutritive activity until the old equilibrium is reëstablished. Not alone can the nutritive activity be awakened by the katabolic changes produced by the functional activity, but it also seems that the nutritive activity can be awakened by certain selective chemical substances. The experiments of Hertwig, Loeb and others have demonstrated this. Unfertilized eggs of lower animals being subjected to certain chemical substances were caused to begin cell division. This cell division was no doubt due to the onset of the nutritive process, the cell having reached its limit of capacity and hence division set in (Spencer's law of growth). Thus it seems that the functional activity can only be awakened by external stimulation. The nutritive activity can be awakened: (1) by the katabolic condition in the cell caused by the functional activity in order to replace the used up material and energy and bring

Digitized by Google

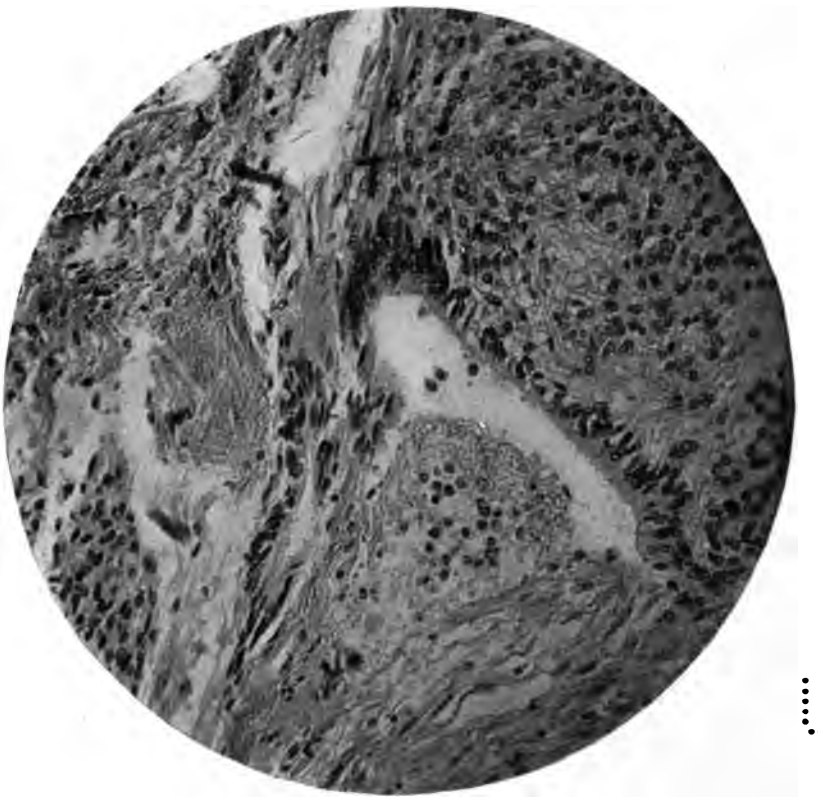


FIG. 10.—High power photograph showing the formation of a cyst with the cells arranging themselves in a characteristic way to form the ependyma lining.

Digitized by Google

Digitized by Google

the cell back into its state of equilibrium; (2) the nutritive process seems capable of being stimulated to activity by bringing a quiescent cell in contact with definite chemical substances.

This type of stimulation of the nutritive activity leads to the awakening of the formative activity, especially in those cells that have never developed any functional activity or only to a very slight degree, such as epithelial, connective tissue and endothelial cells, etc., whereas in those cells that have become highly specialized, which are constantly functionating, it is likely that when they are exposed to a chemical substance which stimulates the nutritive activity, instead of reaching the limit of capacity and dividing as the cells do which are functionally not active, their threshold of functional activity is lowered to such an extent that very much weaker stimulations can cause the cell to react, and thereby not allowing the cell to take in enough material in order to reach its limit of capacity. The over-stimulation of the nutritive and functional activity cannot continue indefinitely without causing the cell to break down.

This is no doubt the reason we never have neoplasms develop from adult cells which have been functionally very active, such as nerve cells, muscle cells, etc., and when we do find neoplasms of such cells, it is very likely that they have developed from cells that have never functionated but have remained in their embryonic state, dissociated from their fellow cells.

In a normal individual the glia cells are in a dormant state; when, however, a hemorrhage or any destructive lesion affects the central nervous system we find that the glia cells are beginning to functionate, due to the external stimulation caused by the lesion and products of the lesion; when this irritation subsides the gliosis ceases; in other words, it is distinctly confined to the area affected by the lesion.

Digitized by Google

In syringomyelia or in cases of progressive glioses of the brain, which I consider an analogous condition, the threshold of functional activity in the glia cells has been lowered so much by a hormone, let us say hypothetically, that the exciting cause, inflammation, hemorrhage, etc., has here set up a gliosis, which does not confine itself to the area involved by the exciting cause, but the increasing glia fibrils are sufficient to awaken the functional activity of the surrounding abnormal sensitive glia cells and so the lesion progresses indefinitely. This would explain why in one case of encephalitis due to measles, scarlet fever, trauma, etc., we will later see a progressive gliosis developing, sometimes involving the whole hemisphere, whereas in another individual the gliosis will not spread beyond the area of the original lesion and will cease when the irritation ceases. The same holds true of a syringomyelia following a trauma of the cord.

In the above case we had a central gliosis with a gliomatosis in the lumbar region extending into and destroying the fibers in the posterior root zones, which accounted for the loss of sensation over the area supplied by the first, second, third and fourth lumbar roots. From the symptoms which were present, all being explained by the gliomatosis, there is *no* reason to believe that the neuro-epithelioma existed at the time of the operation. Judging from the appearance of the cells, the tumor was a very rapidly growing neoplasm, and as the symptoms which the patient presented did not change to any marked degree during the last year of his life, we can again infer that the tumor did not exist at the time of the operation. Why, then, did this tumor develop so rapidly?

The glia cells in the area of gliosis and gliomatosis were in a state of functional activity at the time of the operation. The tremendous shock produced upon the cord by the operation, in

Digitized by Google

addition to the hemorrhage, was sufficient to change the functional activity of the glia cells in the lumbar region to the formative activity, the result of which was the neoplasm.

Just why an injury, such as hemorrhage, contusion of tissue, etc., should lead to the awakening of the formative activity is difficult to say, but if we follow out the reasoning of the above hypothesis, then this injury or contusion stimulates the nutritive activity excessively, and causes the cell to reach its limit of capacity because of functional activity not being able to use all of the incoming material supplied by the over-active nutritive process, and thereby awakening the formative activity. The development of tumors after injury to tissue is a well-known fact.

Digitized by Google

Digitized by Google

Digitized by Google

FIG. 1.—Patient with septic meningitis, subsequently fatal; relaxed comatose.

FIG. 2.

FIG. 3.

FIGS. 2 and 3.—Method of eliciting the identical reflex or neck-sign, by flexing head on chest.

FIG. 4.—Producing contralateral reflex or leg-sign by passive flexion of one leg, causing a reflex flexion of the other leg.

Digitized by Google

XXXI.

NEW REFLEX SIGNS IN MENINGITIS DIAGNOSIS.*

W. P. Northrup, M. D., Visiting Physician to Children's Ward.

Brudzinski's "new sign" in meningitis is probably one of the best signs in the diagnosis of this disease, although it does not differentiate between the various forms. It consists of reflex actions manifested in what are called the neck-sign and the leg-sign. It comprises two reflex phenomena, the identical reflex (*réflexe identique*) and the contralateral reflex (*réflexe contralatérale*).

The identical reflex is elicited by forcibly flexing the head on the chest, when the arms and legs regularly assume the positions shown in Figs. 2 and 3.

The contralateral reflex is produced by passive flexion of one leg, which causes the fellow limb to draw up and remain in the position shown in Fig. 4.

Of the two signs the neck-sigu is the more constant and is really a refinement of the ordinary "stiff-neck," "rigidity," etc., mentioned in the descriptions of the physical signs in meningitis.

Brudzinski[1] in forty-two cases of meningitis, found the neck-signs (*réflexe identique*) positive in 97 per cent.; the leg-sign (*réflexe contralatérale*) in 66 per cent.; Kernig's sign in 57 per cent., and the Babinski sign in 50 per cent.

Morse[2] examined 400 children, "well, or ill with diseases other than meningitis," and his conclusions are that "neither

*(*Reprinted from The Journal of the American Medical Association, January,* 1911.)

Digitized by Google

the neck-signs nor the contralateral reflex are present in well children or in those ill with diseases other than diseases of the nervous system; and that they are very seldom met in diseases of the nervous system, outside of meningitis." "Their presence is strong evidence in favor of meningitis; their absence does not rule out meningitis."

57 East Seventy-ninth Street.

[1] Brudzinski: Arch. de méd. d. enf., 1909, XII, 745.

[2] Morse, John Lovett: Arch. Pediat., XXVII, 561.

Digitized by Google

XXXII.

THE CHILDREN'S WARD.

THE SERVICE AND RECENT ADDITIONS.

By William P. Northrup, M. D., Visiting Physician to the Children's Ward.

On application for admission to the Children's Service, every effort is made to determine the presence of or possible exposure to contagious diseases, in the case applying.

On admission to the Hospital, each child is received into the Observation Ward. This consists of a large room, with two small separate rooms, lavatory, linen closet and pantry. By this arrangement a child showing suspicious symptoms can be immediately isolated without preventing further admissions. Each child is detained from one to five days in this ward, under strict observation. This allows time for reports on the cultures taken from the nose and throat and on the vaginal smears taken from every female child, whether or not a discharge is present.

To maintain "Individual Precautions," each child is cared for entirely in its own crib. Separate thermometer, tooth brush, comb, face basin, buttock basin, liquid castile soap and powder shaker are in different compartments of a white enameled table at the side of each crib. Bed pans are kept in the lavatory in a 2 per cent. solution of formaldehyde; other utensils are boiled.

When transfer to the children's ward is made, the same individual precautions are observed, except it is impossible to

Digitized by Google

bathe or change the child in bed, because of the required low temperature of the ward and the out-of-door treatment.

The children's ward is divided into two spacious rooms, one for medical and the other for surgical cases. A window extends to the floor on the south side, doing service as a passage to an open-air balcony. There are two isolation rooms entirely separate from the main ward, in which to place children developing symptoms of contagious diseases. The ward accommodates twenty-eight children, varying in age from a few hours, to boys of eight and girls of ten years.

The children spend the most possible part of each day and night on the balcony, pneumonia and septic cases spending the entire twenty-four hours there. Half the balcony is covered with a galvanized iron roof with white canvas awnings, which together keep out the direct rays of the sun, as well as the rain and snow and protect from high winds.

The Attending Physician visits the wards daily. The House Physician makes early morning rounds, inspecting the throat and skin of each child for contagious diseases and prescribing the feedings of the day, based upon his observations. After the prescriptions are written they are transcribed on small tags bearing the date and child's name and sent to the milk laboratory.

The work in the milk laboratory is performed by a junior nurse or probationer, under the direction of a dietitian. A gown covering the uniform is worn during the preparation of the feedings. In making up prescriptions "Walker Gordon" milk is used. Each prescribed mixture for the entire twenty-four hours is poured into sterilized feeding bottles, placed in a carrier with the prescription tag fastened to the handle and kept in an ice box at a temperature of 40 degrees F. As each bottle is taken out for use a metal tag is attached to its neck

Digitized by Google

Digitized by Google

FIG. 1.

FIG. 2.—Bed Screen.

Digitized by Google

for identification. Feedings are brought to the proper temperature by placing them in a hot water bath, and are thereafter kept warm by encasing in a cover made of thick flannel.

Ear examinations are facilitated by keeping a tray ready with the usual aural instruments. An electric bulls-eye light (32 candle power), on an adjustable standard is used. A simple wooden table, high and narrow, with an adjustable top, has proved most useful to the Doctors, not only in making examinations, but in performing such operations as lumbar punctures, aspirations, etc. (Fig. iv.)

A white enameled stand, six feet high, on castors, (Fig. I) is used in giving hypodermoclysis and infusions. The stand is furnished with three shelves. On the lower shelf unsterile utensils are kept, (kidney basin, jar of catgut, tube of silk, splints, adhesive plaster and bandages.) On the second shelf are sterile "bundles" of instruments for hypodermoclysis, aspirations and infusions, also solution-glasses for the "Scrub Up." The top shelf holds two bottles of saline solution. The height of the top shelf can be adjusted to give the amount of pressure desired. This outfit, with the aid of a thermostat, which keeps the saline constantly hot, makes it possible to prepare for these emergency treatments almost immediately.

Protecting Screens.

Figure II is a "Grille," or bed screen. It consists of a three-leaf wire screen with two-way hinges. The screen is four feet high, each leaf three feet wide. Two such screens or units, will entirely enclose a child's bed.

A single unit is sufficient ordinarily to keep other patients away. The psychological effect on children, nurses and visitors is to indicate unmistakably that no one is to approach. When the bed is entirely enclosed, nurses can reach over the screen

Digitized by Google

for many purposes of ward service, the screen protecting from contact of their dresses with the bedding.

Children very ill with pneumonia or other acute diseases or surgical patients operated on for appendicitis or empyema are frequently "carriers of infectious diseases, though not themselves suffering from such diseases." These patients need the best ward facilities, good air and good nursing. To put them in small isolating rooms deprives them of both.

We act upon the conviction that the infecting agent of contagious diseases is transferred from patient to patient by contact or by very near approach, say within the striking distance of coughing and sneezing, and that practically the absolute separation by even a few feet renders the infected patient harmless to its neighbors.

In Figure III are seen a series of screens surrounding two cases of typhoid fever. The natural desire of convalescent children to "swap" toys is thus obviated. As a matter of fact, a particularly generous typhoid constantly wishing to *donate* his toys to his runabout friends gave rise to the present screens.

Thus far, we have treated safely several surgical cases, "carriers" of suspicious bacilli, a case of chicken-pox, of vaginitis in a surgical child and several cases of typhoid. It goes without saying that the nurses who care for these children are under special instructions and they treat the cases as quarantined, and though they do other work in the ward, have certain limitations to their duties.

Similar practices have been in vogue in some Paris Hospitals and the use of these screens has the approval of Dr. Herman M. Biggs, of the Health Department, who has personally inspected the ward work, and Quarantine Officer Dr. A. H. Doty. They are assured that most diligent care is constantly exercised in the service.

Digitized by Google

FIG. 3.

Digitized by Google

FIG. 4.

FIG. 5.

Digitized by Google

The moral lesson, it is hoped, will ultimately reach the laity. It is not uncommon for mothers from irrational fear to refuse to pass the front door of a house which harbors a quarantined case. Children are infected by contact or near approach, frequently so early in the development of the case that it is unrecognizable. Prevention from contact is the most important precaution.

Examination Table.

Figure IV shows an examination table which enables the physician to work with comfort. To determine slight comparative dullness of one side of the chest, it is necessary to have the smallest infants lie quite flat on an elevated smooth surface. If a tiny infant is held on the shoulder of a nurse or on the lap, the chest rests on irregular surfaces, and such irregularities will modify the percussion note. The head of the table can be raised or lowered, rendering the table useful in intubations, aspirations punctures, etc. This constitutes one of those minor helps in exact examination which give great comfort to the worker. It is almost impossible for one to bend low and listen for a sufficiently long time to make a satisfactory diagnosis.

The Crib Warmer.

Figure V is the Crib-warmer. This consists of an asbestos box containing an electric heater, above this an asbestos trough in which rests the bassinet. This simple warmer can be readily made by using an ordinary electric foot warmer, asbestos boards, insulated wire cable, couplings with switch which allow the current to be "high," "low," "moderate," or "off." Though to reach perfection, a somewhat more costly apparatus is desirable.

Digitized by Google

Poorly nourished infants require artificial heat until they can furnish their own. Especially is this true in such cool wards as those of our hospital. A baby with cold feet cannot digest. Hot water bottles are perilous, expensive, troublesome. There is constant fear of burning the baby through the bursting of a hot bag.

The results with the latest modification of the baby warmer are satisfactory. It is easy to regulate the heat, to keep it constant day and night and there is no danger of burning the occupant. The electricity sufficient for an ordinary 16 c. p. illuminating bulb is sufficient. Six warmers are in constant use, and they have been found to be less costly, less troublesome and more effective than hot water bottles. The heat comes from below, warming the bed uniformly and tempering the atmosphere breathed without confining it. It may take the place of the usual incubator for new-born babies. Our best test has been in the care of twins weighing four and one-half pounds at four months. These have doubled their weight at the present writing.

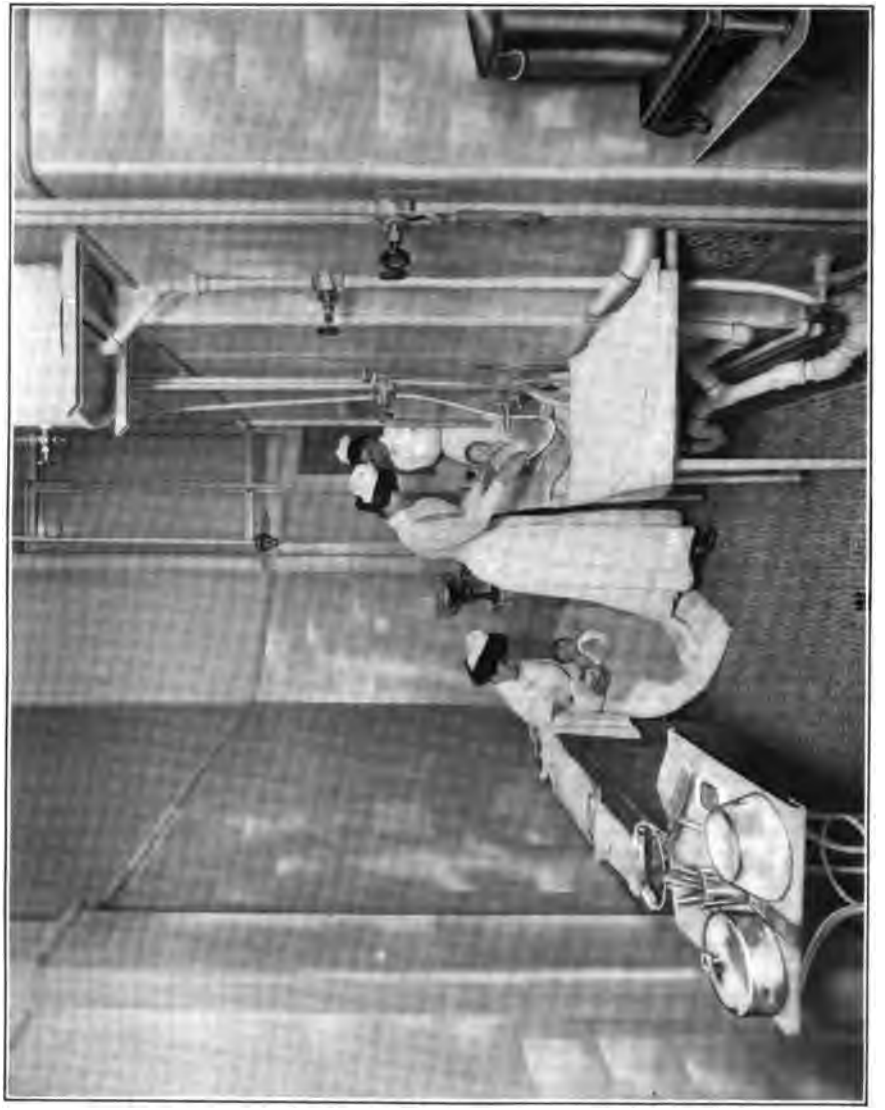
Bathing Children.

Requirements: (1) A warm washing, dressing, and changing-room with atmosphere warm (75 degrees F. and more), furniture, walls, and floor warm; fresh clothing, diapers and towels warm; water warm—in short, everything warm.

(2) Facilities for washing and dressing infants, comfortably to the nurses as well as to the babies, and in the shortest possible time.

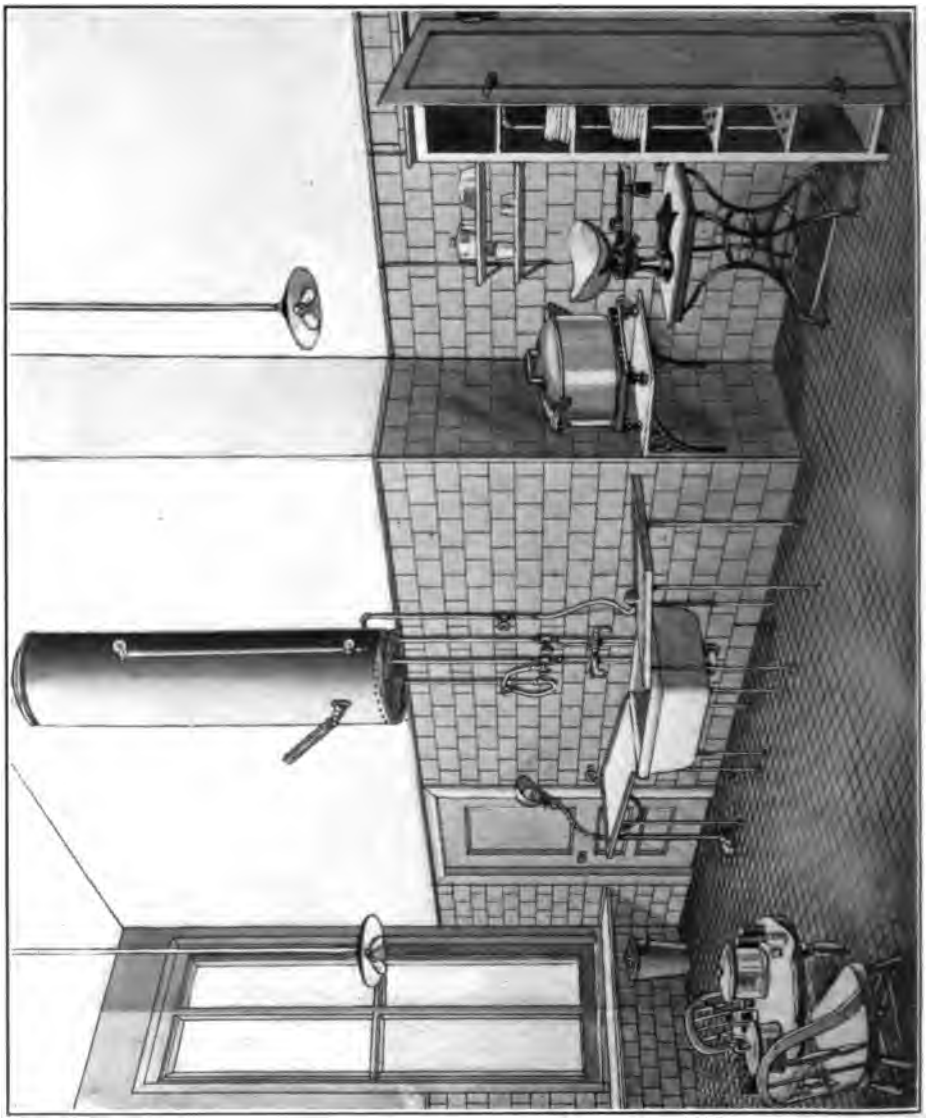
(3) Assurance that there shall be no possibility of scalding or infection.

Digitized by Google



WASHING THE BABIES.

Digitized by Google



THE BABIES' BATH ROOM.

Digitized by Google

What is Provided in the Children's Ward.

A dressing room kept at a temperature of 70 to 75 degrees F. All baths and treatments are given in this room, except to children under suspicion of contagion, such children are treated in their beds or in the "Detention Room."

Bath tubs for the Children's Ward have been abolished as they were thought to be one great source of infection. Marble slabs sloping to a sink have been substituted, with sprays for cleansing the skin. When the baby is undressed it is laid on a clean bath towel covering the marble slab, and is sponged off with liquid castile soap on soft gauze and given a thorough spraying. He is then dried with a soft warm towel and dressed in the usual way. Two low chairs and a low table furnished with the necessary supplies make it convenient for the nurse to give the eyes, ears, and nose a proper cleaning, and the metallic cabinet blanket warmer keeps the clean clothing and diapers at a desirable degree of warmth in the cold season. The towels used during the morning bathing hour are immediately boiled in a small boiler placed at the side of the room and are dried in the drying room on the same floor. This is a saving to the laundry and prevents the mixing of towels. Soiled diapers are placed in large paper bags, and are carried to the rinse house twice daily, where they soak twelve hours in a solution of formaldehyde. Specimens for examination are collected during the night and are kept in a covered agate can. The addition of this dressing room has proved a great luxury for the baby and a wonderful time saver for the nurse.

In Figure VI one sees an eighty-gallon tank; the water heated at will, usually to 103 degrees F. The temperature is read off on the thermometer projecting from the left of the lower quarter. This tank is filled by the same nurse each day, the temperature noted by the head nurse and the hot and cold

Digitized by Google

intake pipes shut off till further orders. This insures a constant temperature (103 degrees F.) in the tank and about 100 degrees F. as it runs from the spray. The water gauge shows on the face of the tank. In this glass tube the amount of water in the reservoir can be easily noted. Mixing the hot and cold water is effected as follows: The hot and cold water pipes are turned on together while the filling and temperature are noted by the nurse deputized for this purpose. The hot and cold water pipes within the tank terminate in four points somewhat like miniature gas fixtures, the hot water tip pointing downward, the cold water pipes pointing upward. The current of the two streams goes against their gravity tendency and so interdigitate that a thorough intermingling of currents is effected, and there can be no layers of hot and cold water. The contained water is of uniform temperature throughout.

Below the tank are seen two flexible rubber pipes terminating in the usual metal bath spray tips. From these, it is designed, that the water shall flow at 100 degrees F. uniformly during the entire morning's work.

On the next lower level is seen a sink winged with two sloping marble slabs.

To the extreme right is seen the hot closet from which the fresh clothing is taken dry and hot.

At the extreme left are seen the low nursery tables and chairs.

It is noted that a very large window lets in a flood of light so that the slightest eruption or change of color or abnormal appearance of the mouth, tongue, or eyes can be easily detected. An electric reflector in addition to the overhead lights serves the same purpose at night. There are two doors, one leading to the corridor and one (that shown in the illustration) to the toilet.

Digitized by Google

CONVALESCENTS.

STUDENTS RECEIVING INSTRUCTION.

Digitized by Google

Digitized by Google

The present facilities, above described, are the result of much studious attention on the part of the heads of the various hospital departments, with the result:

1. The babies are washed in at least half the time.

2. Danger from infection from promiscuous bathing is avoided.

3. Mishaps from use of over-hot water are avoided.

Digitized by Google

Digitized by Google

XXXIII.

AN APPARATUS FOR THE COLLECTION OF THE EXCRETA OF INFANTS.*

EUGENE F. DU BOIS, M. D., LATELY PATHOLOGICAL EXTERNE.

The collection of the excreta of male infants is not a difficult matter. All that is necessary is to immobilize the child's pelvis, adjust the proper receptacles and let nature take its course.

Many kinds of apparatus have been used for this purpose and there is quite an extensive literature on the subject. This is well reviewed by Schabad[1] and by Langstein,[2] who also describes the technic of the investigation of the problems of the metabolism of children. Most of the devices for collecting urine go back to the girdle and test-tube principle of Raudnitz.[3] The devices for holding the child in one position have their origin in the hammock principle of Bendix,[4] modified later by Bendix and Finkelstein.[5] The hammock is tied to the ends and sides of the crib and the child fastened with his body resting on a support made of pillows, his legs spread apart and immobilized, his buttocks slung free over a dish or rubber cloth and his penis placed in a tube which leads to a glass receptacle. An American modification by Talbot[6] makes use of a Bradford frame with a round hole for the buttocks.

* From the Pathological Laboratory of the Presbyterian Hospital and the Department of Applied Pharmacology, Cornell University Medical College.

Demonstrated before the Section on Medicine, New York Academy of Medicine, May 17, 1910.

(*Reprinted from the American Journal of Diseases of Children, December*, 1911.)

Digitized by Google

A limited experience with several of these devices showed that it was necessary to use a good deal of restraint and a good deal of vigilance or the baby would get out of position. The child, although he was really warm and comfortable, looked chilly and uncomfortable. This roused unfavorable comment from nurses, parents and visitors. The apparatus of Howland and Cooke[7] is free from most of these disadvantages and does its work with absolute accuracy. It is easy to make and is perfectly comfortable for the baby, but has the disadvantage of being attached to the crib. This makes it bulky and hard to move and also somewhat conspicuous to anxious parents. Still it is probably the most convenient form of apparatus for much of the work done with children.

From the necessities of my work I was forced to make an apparatus (Figs. 1, 2, and 3) which was portable and incon-

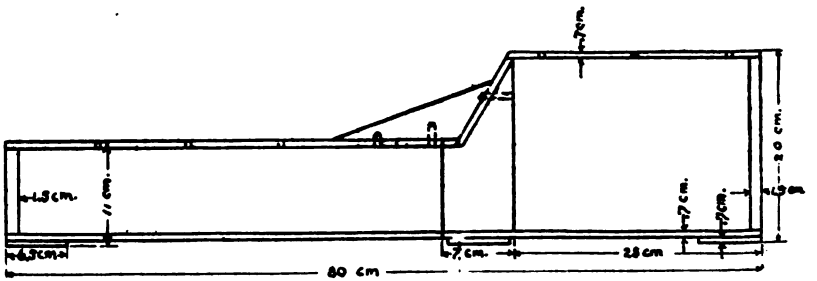


FIG. 1.—Diagram of apparatus for holding infants in metabolism experiments, showing measurements and methods of construction.

spicuous. It seemed desirable also to keep the baby with thighs flexed, as this is the natural position for infants and is the position adopted in most of the recent devices. A frame of wood covered with a mattress was therefore modeled to fit the baby with thighs flexed. An inclined plane under the thighs prevented downward motion, a cloth band over the thighs prevented upward motion and a rounded trough in which the pel-

Digitized by Google

FIG. 2.—The complete apparatus, including mattress, receptacles for holding feces and urine and the girdle for holding the latter.

FIG. 3.—The apparatus assembled and the infant secured in place.

Digitized by Google

Digitized by Google